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BEING THE

ANNUAL REPORTS

OF VARIOUS

PUBLIC OFFICERS AND INSTITUTIONS

FOR THE YEAR

1911.

PUBLISHED BY THE SECRETARY OF THE COMMONWEALTH.

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FORTY-THIRD ANNUAL REPORT

OF THE

STATE BOARD OF HEALTH

OF

MASSACHUSETTS.

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1912.

APPROVED BY
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Analyst of Food and Drugs.

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Chemist.

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GENERAL REPORT.

In accordance with the provisions of chapter 211 of the Acts of 1905, the following report of the work of the several departments of the State Board of Health is presented for the fiscal year ended Nov. 30, 1911, on which date the Board was constituted as follows: —

HENRY P. WALCOTT, M.D., Cambridge, *Chairman.*

CLEMENT F. COOGAN, Pittsfield.	HIRAM F. MILLS, A.M., C.E., Lawrence.
JOSEPH A. PLOUFF, Ware.	ROBERT W. LOVETT, M.D., Boston.
JULIAN A. MEAD, M.D., Watertown.	C. E. MCGILLICUDDY, Esq., Worcester.

On Feb. 1, 1911, Mr. James W. Hull of Pittsfield, a member of the Board since 1893, died of pneumonia, and at a meeting of the Board held Feb. 2, 1911, it was voted that the following minutes be placed upon the records: —

> James W. Hull was appointed a member of the State Board of Health in 1893, and was reappointed in 1898 and 1905. He gave to the State an interested, active and intelligent service. Constant in attendance at the stated meetings of the Board, he was at no time forgetful of the interests of the public health in all of its varied and complicated relations. The Board loses a wise counsellor, a most acceptable associate and a valued friend.

On April 26, 1911, Mr. Clement F. Coogan was appointed by His Excellency Eugene Noble Foss to fill out Mr. Hull's unexpired term.

On May 21, 1911, Mr. Gerard C. Tobey, a member of the Board since 1893, died, and at a meeting of the State Board of Health held June 1, 1911, it was voted that the following minutes be placed upon the records: —

> At the time of his death, May 21, 1911, Gerard C. Tobey had been a member of this Board for twenty years, and during this long service he was constant and punctual in attendance at the meetings, and faithful in performing the duties of the office. Born in Massachusetts and educated at Harvard, environment and training combined to make him conservative and discreet, and gave him qualities that made his counsel wise and safe. He was kindly and genial and was respected and loved by his fellow members.

Mr. Tobey's term of office would have expired in 1911, and Mr. C. E. McGillicuddy of Worcester was appointed by the Governor as Mr. Tobey's successor.

On Aug. 10, 1911, occurred the death of Col. Charles H. Porter, member of the Board since 1894. Colonel Porter served the Commonwealth well in a number of capacities. He had an honorable record as an officer in the Thirty-ninth Massachusetts Regiment of the Army of the Potomac, and in 1869 he was commissioned lieutenant colonel of the Seventh Massachusetts Infantry. A citizen of Quincy, he took a great interest in local affairs and was the first mayor of his city. In 1899 Colonel Porter was appointed to the Civil Service Commission and served until 1905. During his long and acceptable connection with the State Board of Health he contributed to that body much in the way of faithful and meritorious service.

To fill out the unexpired term of office of Colonel Porter, Mr. Joseph A. Plouff of Ware was appointed by Governor Foss.

INVESTIGATION OF SO-CALLED SANITARY PAPER DRINKING CUPS.

On Jan. 27, 1911, the State Board of Health was requested to investigate the conditions under which the so-called sanitary paper drinking cups are manufactured and prepared for sale or delivery in this Commonwealth, and to report the results of the investigation to the House of Representatives. In response to this order the State Board of Health reported on April 15, 1911, as follows: —

STATE BOARD OF HEALTH, BOSTON, April 15, 1911.

To the Honorable House of Representatives, State House, Boston, Mass.

GENTLEMEN: — On Jan. 27, 1911, the House of Representatives passed the following order: —

> *Ordered,* That the State Board of Health is hereby requested to investigate the conditions under which the so-called sanitary paper drinking cups are manufactured and prepared for sale or delivery in this Commonwealth. Said Board shall report the results of the investigation to the House of Representatives not later than April 15, 1911, with such recommendations as it deems necessary in the interest of public health.
>
> JAMES W. KIMBALL, *Clerk.*

In obedience to the above order the State Board of Health has investigated the conditions under which sanitary drinking cups are manufactured and prepared for sale or delivery in this State, and respectfully submits the following report: —

The companies engaged in the manufacture of sanitary drinking cups in the Commonwealth are the following: —

The American Drinking Water Supply Company, Causeway Street, Boston, Mass.
The Burnitol Manufacturing Company, 39–49 Sudbury Street, Boston, Mass.
Logan, Swift & Brigham Division of the United States Envelope Company, Worcester, Mass.
The Standard Single Service Company, East Pepperell, Mass.

There has been investigated also the establishment of the American Paper Goods Company in Kensington, Conn.

THE AMERICAN DRINKING WATER SUPPLY COMPANY, CAUSEWAY STREET, BOSTON.

The American Drinking Water Supply Company has 45 employees, 20 of whom are minors. The majority of the workers are women. The sole product of this establishment is paper drinking cups, of a variety of shapes and sizes. Stiff cups as well as folding cups are manufactured here.

Cleanliness. — The room where the work is done is large, high studded and clean. It has a cement floor which is kept clean, except for considerable flakes of paraffine, which are unavoidable. This, however, cannot be regarded as objectionable as it tends to keep dust down.

Light. — The workroom has windows on one side only, so that the girls working at benches away from the windows use gaslight all day. The place is being enlarged, and the additional workroom that is being fixed up has much better light.

Ventilation. — On entering the workroom the odors of molten paraffine are very strong. The management has been trying various methods to do away with this objectionable feature. At present they have all the machines by which paraffine is sprayed on the cups hooded, and connected by suction pipes with an exhaust fan, but this is not sufficient to carry off all the fumes. In the method of spraying the paraffine,. air is mixed with it and much of the paraffine is thus volatilized. The fumes before entering the suction pipes pass through a chamber where the paraffine is precipitated. Even with this precaution the suction tubes have to be taken apart frequently and relieved of the deposited paraffine. The company is at present working on a new method of applying the paraffine, which will do away with this objectionable feature.

Water-closets. — Two flush closets, one for each sex, are located in a part of the room away from the workers. These are kept clean.

Processes of Manufacture. — The processes are very simple and few. After the paper is cut by a machine it is brought to the operatives, who do the "forming." This consists of putting the paper around a metal cylinder, spreading paste along the edge and pasting the edges together. The spreading of the paste and the pressing of the edges together are done by a small machine. The cup is then removed from the cylinder and is placed in a movable tray, which brings it to the next operative, who puts a bottom in it. A circular disc of cardboard is placed on the end of a metal cylinder and the formed cup is slipped over the cylinder and pressed down; this fixes the bottom firmly in the cup. The cup is then passed along on a movable tray to be paraffined. It is inserted in a closed chamber, and by means of air pressure molten paraffine is sprayed on the outside of the cup; by means of capillary attraction the inside of the cup is also paraffined. The opening of the chamber gives rise to considerable vapors from the molten paraffine.

The paraffined cups then pass along on a movable tray, and are collected, inspected and packed.

Hygienic Considerations. — In handling the cups in the above processes the hands of the operatives rarely come in contact with the inside of the cup. In one process, which necessitates the insertion of the middle finger to remove the cup from the cylinder, the girls wear rubber cots on the middle fingers.

Cleanliness of the hands of the operatives is insisted upon for sanitary as well as commercial reasons, for an unclean hand will leave stains on the white paper, and all cups in the least soiled are rejected by the inspectors. All the handling of the cups after they are paraffined is done by operatives wearing white cotton gloves.

All the minors examined were found to be in good health, with the exception of the effects of the paraffine vapors referred to above. The hands of all these minors were clean.

The paraffine used was said to be the purest that can be obtained.

THE BURNITOL MANUFACTURING COMPANY, 39–49 SUDBURY STREET, BOSTON.

The Burnitol Manufacturing Company employs 5 operatives. Drinking cups are made only a small portion of the time. The firm manufactures paper cuspidors and sputum flasks. The workroom is high studded, excellently lighted and ventilated, and kept clean.

A folding paper cup only is manufactured, and the processes are similar to those described, except that the paraffine is applied on the inside of the cup by putting the cup around a revolving wick saturated with molten paraffine.

Cleanliness of the hands of the operatives is insisted upon.

LOGAN, SWIFT & BRIGHAM DIVISION OF THE UNITED STATES ENVELOPE COMPANY, WORCESTER, MASS.

Careful inspection of the departments in which the "Sanitas" drinking cups are manufactured shows that the best possible conditions as to cleanliness obtain at the present time at this factory. Up to the present time this concern has manufactured but few of these cups, but is perfecting machinery whereby they can be made without being handled at all by the operatives.

THE STANDARD SINGLE SERVICE COMPANY, EAST PEPPERELL, MASS.

The factory of this concern is in East Pepperell, on the top floor of a building used formerly for a machine shop. It is a new company, formed some time last summer to make milk containers. Drinking cups have now been added to their list.

The floor is somewhat rough, owing to the work previously carried on, but it seemed to be as well kept as possible considering its condition. There is town water in the place. The water-closets are not as good as they should be, but are kept ordinarily clean. There are at present 14 people working in the place, and all seemed to be in good health. There have been a few cases of mumps among the girls, but the company has decided to lay off such employees until entire recovery, with full pay, so that there may be no incentive to conceal cases of illness.

The paper used is a good quality wrapping paper which comes in sheets in well-protected packages. The only material used in the manufacture of the cups and retainers besides the wrapping paper is what is commercially known as cold-water paste and paraffine.

It is machine work up to the point of dipping in hot (over 200° F.) paraffine. This is done by hand on a wire rack, and the cups or retainers are then dried on the bench, nested and packed for shipment.

The cups are carefully handled from beginning to end, and the management realizes that it is under more than ordinary obligation to do the work in a cleanly manner and to keep the product free from pathogenic organisms. If the business warrants it, the company desires to put up new and better buildings.

AMERICAN PAPER GOODS COMPANY, KENSINGTON, CONN.

This concern was, of course, beyond the jurisdiction of the State Board of Health of Massachusetts, but expressed themselves as very glad to have any investigation made which might be of value to this Board.

This concern manufactures bags, envelopes, paper specialties and paper drinking cups. They employ practically 270 people and 20 minors.

The paper from which they make these drinking cups comes from Philadelphia, and is designated as Hercules fiber. It comes wrapped up in bundles weighing 50 pounds. On its arrival at this establishment, a package is opened and the paper is piled in bundles.

The following is the process in the manufacture of these paper cups: —

(1) The paper is taken to presses and cut out on steel dies.

(2) The paper is then taken to a printing room, and is passed through an automatic machine in which it is printed as per order.

(3) The sheets are next taken to another department and are fed into an automatic folding machine, similar to those which fold envelopes.

(4) From this folding machine they are then taken to a paraffine machine, on top of which is a tank in which hot paraffine is kept at a temperature of

150° to 200° F. This machine in front is composed of different compartments. A girl places these folded paper cups in these different forms, and they pass through a series of rollers, which are steam heated. At the same time the hot paraffine is allowed to trickle through the roller. After being saturated with paraffine and rolled, they pass through the machine onto a table. On each side of the table 4 or 5 girls sit and pack the cups in boxes of 50.

(5) These boxes, after being filled, are then taken to the packing and shipping room.

The cups are thus first handled by men in the basement, who have charge of the presses, again by the printer, then by persons who operate the folding machine, and finally by the operator in charge of the paraffine machine, and the girls who pack them.

The factory is clean, well lighted and ventilated. Sanitary conditions regarding toilets are good. None of the closets open into the workroom, but are connected with same, separated by a door.

From the foregoing reports it would seem to be clear that the manufacture of sanitary drinking cups is carried on in the State of Massachusetts under conditions of reasonable cleanliness, and that the public health is in no sense endangered through the use of these cups.

HENRY P. WALCOTT,
Chairman.

INVESTIGATION OF THE SUPPLYING OF PURE DRINKING WATER AND OF SANITARY DRINKING CUPS UPON PASSENGER CARS IN OPERATION UPON THE RAILROADS OF THE COMMONWEALTH.

On March 14, 1911, the State Board of Health and the Board of Railroad Commissioners, sitting jointly, were requested to investigate the supplying of pure drinking water and of sanitary drinking cups upon passenger cars in operation upon the railroads of the Commonwealth, and to report their recommendations to the General Court.

The report called for follows: —

STATE BOARD OF HEALTH, BOSTON, April 15, 1911.

To the General Court of Massachusetts.

On March 14, 1911, the Honorable the Senate adopted the following order: —

Ordered, That the Board of Railroad Commissioners and the State Board of Health, sitting jointly, be requested to investigate forthwith the supplying of pure drinking water and of sanitary drinking cups upon passenger cars in operation upon the railroads of the Commonwealth, and to report their recommendations in writing to the General Court on or before April 15 next.

This order was adopted in concurrence by the House of Representatives on March 16, 1911. Immediately thereafter the Board of Railroad Commissioners and the State Board of Health, sitting jointly, duly organized and proceeded to investigate forthwith: —

First. — The supplying of pure drinking water upon passenger cars in operation upon the railroads of the Commonwealth; and

Second. — The supplying of sanitary drinking cups upon passenger cars in operation upon the railroads of the Commonwealth.

The Joint Board now makes a report of its investigation, together with its recommendations in writing, as follows: —

First, as regards the supplying of pure drinking water.

The chemical analyses of water taken from the trains in different parts of the Commonwealth compare fairly well with the analyses of the municipal water supplies from which the water on the trains was obtained. There were a few samples having an increased amount of organic matter, indicating a want of cleanliness in the tanks or carelessness in handling. In some cases the quality of the water supplied is evidently dependent largely upon the character of the ice used, and especially the degree of care used in handling it. These conditions should be subject to inspection and control by the health authorities.

While the statutes require the railroads to provide pure water, it is evident that it would be unreasonable for the passengers from any community to demand of a railroad company better water than that community provides for its own citizens; but if a railroad company obtains water from a municipal supply, it should see that the water does not deteriorate in its hands. Where ice is used in contact with the water, unless taken from the supplies used for domestic purposes in the communities from which it is obtained, it should be taken from sources of known safety, and should be handled with such care as will prevent its contamination.

Secondly, as regards the supplying of sanitary drinking cups.

The General Court of 1910 enacted chapter 428, "An Act to restrict the use of common drinking cups," which act was approved April 22, 1910. Section 1 reads as follows: —

> SECTION 1. In order to prevent the spread of communicable diseases, the state board of health is hereby authorized to prohibit in such public places, vehicles or buildings as it may designate the providing of a common drinking cup, and the board may establish rules and regulations for this purpose.

At a meeting of the State Board of Health held July 21, 1910, the following regulations were made concerning the use of the common drinking cup, in accordance with the provisions of said chapter 428 of the Acts of 1910. Said regulations provided that —

> On and after Oct. 1, 1910, it shall be unlawful to provide a common drinking cup: —
>
> (*a*) In any public park, street or way.
>
> (*b*) In any building or premises used as a public institution, hotel, theatre, public hall or public school.
>
> (*c*) In any railroad station, railroad car, steam or ferry boat.

By virtue of the foregoing regulations of the State Board of Health the railroad corporations withdrew the use of the common drinking cup upon their passenger trains in this Commonwealth.

The Joint Board, after investigation, is of opinion that the public interest requires that the several railroad corporations of the Commonwealth make some provision for the supply of pure drinking water to their passengers in trains running thirty miles or more. For distances of less than thirty miles adequate provision for the supply of pure drinking water can reasonably be made at the larger stations of the several companies.

With respect to the method of distribution of drinking water in trains running thirty miles or more, the Joint Board recommends that the railroad companies supply, free of charge, to passengers, on application, a sanitary drinking cup for obtaining such drinking water. Nothing in this recommendation, however, shall prevent the railroad companies from installing any other device for supplying, free of charge, drinking water to its passengers, provided such device has received the approval of the State Board of Health.

WALTER PERLEY HALL,
GEORGE W. BISHOP,
CLINTON WHITE,
Board of Railroad Commissioners.

HENRY P. WALCOTT,
HIRAM F. MILLS,
JULIAN A. MEAD,
ROBERT W. LOVETT,
State Board of Health.

Subsequent to this report, the Legislature took the matter under advisement and passed the following bill: —

ACTS OF 1911, CHAPTER 491.

AN ACT RELATIVE TO THE FURNISHING OF DRINKING WATER ON PASSENGER TRAINS.

Be it enacted, etc., as follows:

SECTION 1. Every railroad car while in use for the transportation of passengers, upon a train running thirty miles or more, shall be provided with a sufficient quantity of pure drinking water in such place or places in the car as will be convenient for the passengers, and with individual drinking cups which shall be accessible to the passengers. No charge shall be made for the water or for the drinking cups. The water and cups supplied shall be subject to the supervision and approval of the state board of health; and the said board shall enforce the provisions of this act. Equivalent methods of furnishing drinking water free to the passengers may be provided, instead of the foregoing, provided that the same are approved by the state board of health.

SECTION 2. Violations of this act shall be punished by a fine of not less than twenty-five dollars for each trip made by a car used for transporting passengers and not provided with water and utensils for its distribution in accordance with the provisions hereof.

SECTION 3. This act shall take effect on the fifteenth day of June in the current year. [*Approved May 27, 1911.*

LEGISLATION RELATIVE TO THE APPOINTMENT OF INSPECTORS OF SLAUGHTERING.

On April 20, 1911, the Legislature passed chapter 297, Acts of 1911, relative to the transfer of certain powers from the Cattle Bureau of the State Board of Agriculture to the State Board of Health. It was found, however, that the act was defective, in that the manner of choosing inspectors of slaughtering was not adequately defined. The matter was taken up with the committee on agriculture, and chapter 534 of the Acts of 1911 was introduced and passed to remedy the above-mentioned defect.

ACTS OF 1911, CHAPTER 297.

AN ACT TO TRANSFER CERTAIN POWERS FROM THE CATTLE BUREAU OF THE STATE BOARD OF AGRICULTURE TO THE STATE BOARD OF HEALTH.

Be it enacted, etc., as follows:

SECTION 1. Section seven of chapter ninety of the Revised Laws is hereby amended by striking out the words "The board", in the first line, and inserting in place thereof the words: — The state board of health, — so as to read as follows: — *Section 7.* The state board of health may make regulations for the inspection of meat, which shall conform to the regulations of the United States bureau of animal industry for the inspection of meat for export and for interstate commerce.

SECTION 2. Section one hundred of chapter seventy-five of the Revised Laws is hereby amended by striking out the words "board of cattle commissioners", in the fifteenth line, and inserting in place thereof the words: — state board of health, — so as to read as follows: — *Section 100.* The mayor and aldermen, selectmen, or such other officers as they shall designate, or in a town having a population of more than five thousand, the board of health, if any, may annually issue licenses to carry on the business of slaughtering neat cattle, sheep or swine to applicants therefor. The fee for each license shall be one dollar. The license shall name the persons licensed to conduct such business, and the building or establishment in which it is to be carried on, and it shall continue in force until the first day of May of the year next ensuing, unless sooner forfeited or rendered void. A record shall be kept by the board or officers authorized to issue licenses of all applications for licenses under the provisions of the preceding section and of all licenses issued, which shall be evidence of the issue of any such license. Such board or officers shall annually, on or before the first day of June, send to the state board of health a copy of every application made to them under the provisions of the preceding section and their action thereon, and a list of all persons with their addresses, who although engaged in the business named in the preceding section on the last day of the previous April, failed to make application for a license.

Section 3. Section one hundred and one of chapter seventy-five of the Revised Laws is hereby amended by striking out the words "a member of the board of health or of an inspector appointed therefor by said board", in the fifth and sixth lines, and inserting in place thereof the words:— an inspector of the state board of health,— so as to read as follows:— *Section 101.* A licensee under the provisions of the preceding section shall not slaughter any such animals, or cause them to be slaughtered at such slaughter house or establishment, on any days other than those specified in the application for such license, except in the presence of an inspector of the state board of health; but he may at any time change the days for slaughtering such animals, by giving at least seven days' written notice thereof to the board or officer authorized to issue licenses, who shall immediately give written notice of such change to such inspector of such city or town.

Section 4. Section one hundred and two of chapter seventy-five of the Revised Laws is hereby amended by striking out the words "board of cattle commissioners", in the seventh line, and inserting in place thereof the words:— state board of health,— so as to read as follows:— *Section 102.* Such inspector as has been appointed by the board of health shall be present at all licensed slaughter houses or establishments upon the days designated for slaughter by the licensee, as provided in the preceding section, and there carefully examine the carcasses of all animals at the time of slaughter. Such inspection shall be made in such manner and under such rules and regulations as the state board of health may determine and direct. If, in the opinion of an inspector, any carcass, or any meat or product thereof is diseased, corrupted, unwholesome or unfit for food, he shall seize it and cause it to be destroyed, as provided in section seventy of chapter fifty-six.

Section 5. Section one hundred and three of chapter seventy-five of the Revised Laws, as set forth in chapter two hundred and twenty of the acts of the year nineteen hundred and three, and as amended by chapter four hundred and seventy-one of the acts of the year nineteen hundred and nine, is hereby further amended by striking out the words "cattle bureau of the state board of agriculture", in the twelfth line, and inserting in place thereof the words:— state board of health,— so as to read as follows:— *Section 103.* In a slaughtering establishment wherein inspection and branding are not carried on under the rules and regulations for the inspection of live stock and other products, established by the United States department of agriculture in accordance with acts of congress, the carcasses of animals slaughtered under the provisions of the four preceding sections shall at the time of slaughter, if not condemned, be stamped or branded by the inspector thereof in like manner as those inspected by the United States bureau of animal industry for interstate trade, by a stamp or brand designed for the purpose by the state board of health, which shall be furnished by it to the board of health of a city or town applying therefor. Such stamps shall be uniform in design throughout the commonwealth, but shall contain the name of the city or town in which they are used.

SECTION 6. For the purposes of this act inspectors of meats and provisions shall be appointed, shall be compensated, and may be removed in accordance with the provisions of law relating to inspectors of animals, except that the state board of health shall in respect to its inspectors perform the duties and exercise the authority imposed by law upon the chief of the cattle bureau of the state board of agriculture in respect to inspectors of animals. The first appointments under this act shall be made within thirty days after its passage.

SECTION 7. This act shall take effect upon its passage. [*Approved April 20, 1911.*

ACTS OF 1911, CHAPTER 534.

AN ACT RELATIVE TO THE APPOINTMENT OF INSPECTORS OF SLAUGHTERING.

Be it enacted, etc., as follows:

SECTION 1. Section one hundred and one of chapter seventy-five of the Revised Laws, as amended by section three of chapter two hundred and ninety-seven of the acts of the year nineteen hundred and eleven, is hereby further amended by striking out the words "an inspector of the state board of health", in the fifth and sixth lines, and inserting in place thereof the words: — a member of the board of health or of an inspector appointed therefor by said board, — so as to read as follows: — *Section 101.* A licensee under the provisions of the preceding section shall not slaughter any such animals, or cause them to be slaughtered at such slaughter house or establishment, on any days other than those specified in the application for such license, except in the presence of a member of the board of health or of an inspector appointed therefor by said board; but he may at any time change the days for slaughtering such animals, by giving at least seven days' written notice thereof to the board or officer authorized to issue licenses, who shall immediately give written notice of such change to such inspector of such city or town.

SECTION 2. Section six of chapter two hundred and ninety-seven of the acts of the year nineteen hundred and eleven is hereby amended by striking out said section and inserting in place thereof the following: — *Section 6.*

For the purposes of this act inspectors shall be appointed, shall be compensated, and may be removed in accordance with the provisions of law relating to inspectors of animals, except that the appointment of such inspectors shall be made by the local boards of health and except that in respect to such inspectors the state board of health shall perform the duties and exercise the authority imposed by law upon the chief of the cattle bureau of the state board of agriculture in respect to inspectors of animals. The first appointments under this act shall be made within thirty days after its passage.

SECTION 3. This act shall take effect upon its passage. [*Approved June 9, 1911.*

As a result of these two acts the State Board of Health is given considerable additional power over the business of slaughtering in the Commonwealth. In the first place, although the inspectors of slaughtering are appointed finally by local boards of health, nominations for this office must be submitted first to the State Board of Health for its approval. In the second place, the State Board of Health is given the power to make rules and regulations as to the manner in which inspection of slaughtering shall be carried on; such rules, however, being subject to approval by the Governor and Council. Thirdly, copies of all licenses issued to those wishing to engage in the business of slaughtering must be on file in the office of the State Board of Health. Fourthly, the stamps for use in the inspection of slaughtering are furnished now by the State Board of Health instead of by the Cattle Bureau of the State Board of Agriculture.

A short summary of the Board's action in relation to the inspection of slaughtering appears in the Supplement.

It is apparent that the work accomplished during the year 1911 has been far from complete, but it is expected with the incoming year to bring the business of slaughtering under much closer supervision by the Board, especially if the Legislature allows an extra appropriation of $5,000 for this purpose.

Even a superficial acquaintance with slaughtering conditions in the State of Massachusetts shows that there are many points which offer opportunities for criticism. A great majority of the inspectors of slaughtering are persons but slightly trained in the examination of animals, healthy or diseased. It is, however, apparent that with the large number of small slaughter-houses scattered throughout the State, it would be practically impossible to secure veterinarians for inspection at every establishment, even if the individual towns were willing to pay a salary sufficient to attract such trained men.

The proper solution of the slaughtering situation in this State would seem to lie in some plan similar to that suggested to the Legislature in 1909 and 1910, whereby a certain number of district slaughter-houses would be established throughout the Commonwealth, over which a competent veterinary surgeon, as inspector, would have jurisdiction, and to which all animals for slaughter would be brought from the surrounding towns. Under present conditions, as has been stated, inspectors appointed by local boards of health are, in the great majority of instances, but moderately efficient. In fact, the law is so worded that inspection of slaughtering can be carried on by members of a board of health without the approval of the State Board of Health, even though said members, if nominated as inspectors, might be promptly disapproved by the State Board of Health.

Another condition which needs correction arises from the fact that under the United States law animals may be brought into this State in interstate commerce under two types of so-called exemption from inspection and branding: —

(*a*) The retail butchers' exemption; and

(*b*) The farmers' exemption.

Furthermore, the Massachusetts law provides that animals slaughtered by the farmer on the farm must be inspected but need not be stamped. Animals less than six months old, moreover, if slaughtered by the farmer on the farm, require neither inspection nor branding.

There are, therefore, three conditions under which carcasses unstamped may be sold in this State, apparently without legal hindrance. This is a situation which should receive the attention of the Legislature.

Licenses for Slaughter-houses.

Since the enactment of section 2, chapter 297 of the Acts of 1911, requiring that a copy of every application made to carry on the business of slaughtering be filed in the office of the State Board of Health, 174 applications have been received from 70 cities and towns in this State.

Water Supply and Sewerage.

The State Board of Health presents herewith a report of its doings for the twelve months ended Nov. 30, 1911, under the provisions of laws relating to the protection of the purity of inland waters, as required by chapter 75, section 115, of the Revised Laws.

The Board has received during the year 176 applications for advice with reference to water supply, sewerage, sewage disposal and matters relating thereto, — a much larger number than in any previous year.

Of these applications, 130 were in relation to water supply, 6 to sources of ice supply, 21 to sewerage, drainage and sewage disposal, 6 to the pollution of streams and 13 to miscellaneous matters.

WATER SUPPLIES.

Public water supplies were introduced during the year in the towns of West Bridgewater (supplied from the city of Brockton), Blackstone (supplied from the city of Woonsocket, R. I.), Russell, Ashland, Medway, Deerfield (Fire District), Worthington (Fire District), Leicester (Cherry Valley and Rochdale Water District) and South Hadley (South Hadley Fire District No. 2). Water supplies had already been introduced in other villages in the towns of Deerfield, Leicester and South Hadley. Of the 354 cities and towns in the State, 198, containing by the census of 1910 a population of 3,184,846, are provided with public water supplies. The remaining towns, 156 in number, contained by the census of 1910 a population of 181,570. These towns are practically all of small size, there being only 6, viz., Barnstable, Dartmouth, Sutton, Templeton, Tewksbury and Warren, which have a population in excess of 3,000. At the end of the year works were already under construction for the supply of the town of Barnstable, and legislative authority has recently been obtained for the construction of water works in one of the other towns mentioned.

Of the 198 cities and towns having public water supplies, 157 are supplied wholly or in part from municipal or district works, while 41 are supplied by water companies.

DEFICIENCY IN RAINFALL AND ITS EFFECT UPON PUBLIC WATER SUPPLIES.

The year 1911, like several of its immediate predecessors, was marked during its earlier months by a decided deficiency in rainfall. Unlike the conditions of the preceding year, the deficiency in 1911 was most decided in the months of the winter and spring, — the months of high flow in the streams, which are depended upon to fill the storage reservoirs of the large surface supplies.

Meteorological observations in various parts of the State show that the rainfall from January to June, inclusive, was 7.08 inches below the normal for that period, this deficiency amounting to a reduction of 33 per cent., or one-third of the total normal rainfall for the first six months of the year. In consequence of these conditions many storage reservoirs failed to fill, causing a very decided shortage of water in many cities and towns. Fortunately the rainfall increased greatly in the latter part of August, and from that time until the end of November was greater than has occurred in that period of the year for several years. In consequence, the further serious lowering of the reservoirs in the latter part of the year was prevented, and at the end of the year the quantity of water in storage was, as a rule, about the same as at the end of 1910. As in the previous year, emergency supplies became necessary, and in some cases it was only by the use of such supplies that a water famine was prevented.

SANITARY PROTECTION OF PUBLIC WATER SUPPLIES.

Under the provisions of chapter 499 of the Acts of the year 1908 cities, towns and fire districts duly established by legislative authority were authorized to take lands and other property under certain conditions to preserve the purity of their water supplies. This act has now been amended by the provisions of chapter 135 of the Acts of 1911 so that the authority granted to cities, towns and fire districts has been extended to water supply districts established by legislative authority. The act is an important one, since under its provisions it is practicable to take prompt action to protect public water supplies by taking lands or buildings where circumstances arise which make such action necessary.

Under authority of chapter 75, section 113, of the Revised Laws, authorizing the State Board of Health to make rules and regulations for the sanitary protection of public water supplies, the Board up to the present time has made rules and regulations for the sanitary protection of the sources of water supply of the following cities and towns: —

Abington and Rockland.
Amherst.
Andover.
Attleborough.
Braintree.
Brockton and Whitman.
Cambridge.
Chicopee.
Concord.
Danvers and Middleton.
Easthampton.
Fall River.
Falmouth.
Fitchburg.
Gardner.
Greenfield.
Haverhill.
Holyoke.
Hudson.
Lincoln and Concord.
Lynn.
Marlborough.
Maynard.
Montague.
Northampton.
Northborough.
Norwood.
Peabody.
Pittsfield.
Plymouth.
Randolph and Holbrook.
Rockport.
Russell.
Salem and Beverly.

Springfield.
Springfield and Ludlow.
Stockbridge.
Taunton.
Wakefield.
Westfield.
West Springfield.
Weymouth.
Winchester.
Worcester.

In addition to the above, the water supplies of the metropolitan water district, including 18 cities and towns, are also protected by such rules.

SUPERVISION OF WATER COMPANIES.

Under the provisions of chapter 319 of the Acts of the year 1909, entitled "An Act to provide for the supervision of water companies by the State Board of Health," the Board is authorized to investigate complaints in writing relative to the service furnished in any city or town, or the charges therefor made by any company engaged in the business of supplying water to such city or town or the inhabitants thereof, and to give a public hearing to the complainant or complainants and to the company; and after the hearing the Board is authorized to make "such recommendations concerning the reduction, modification or continuation of such charges for service, or concerning improvements in the quality of the service or extensions of the same or concerning other matters in the premises as the board shall deem just and proper." The act further provides that "any such recommendations shall be transmitted in writing by the board to the company complained of, and a report of the proceedings and result thereof shall be included in the annual report of the board, together with a statement of the action, if any, taken by the company upon the recommendation."

Under the above law a petition was presented to the Board by the selectmen of the town of Dedham, in accordance with the provisions of the act, early in 1910, making complaint relative to the charges for service by the Dedham Water Company, and requesting action by the Board thereon. The petition was as follows: —

At the adjourned session of the annual town meeting, held April 5, 1910, Article 55 of the town meeting warrant was as follows: To see if the town will instruct the selectmen to prepare and file with the State Board of Health a complaint relative to the charges for service by the Dedham Water Company, as provided in chapter 319 of the Acts of 1909, Commonwealth of Massachusetts, entitled "An Act to provide for the supervision of water companies by the State Board of Health," and to make such appropriation as may be necessary to provide for the entering and hearing of such complaint.

Under this article the town voted: "That the selectmen be instructed to file with the State Board of Health, on or before May 1, 1910, a copy of the following resolutions, requesting a thorough investigation by said Board of the rates for service charged by said water company.

"*Resolved*, That it is the sense of a majority of the citizens assembled at this meeting that the rates charged for service by the Dedham Water Company are unreasonable, unfair and inequitable."

At the same time the following further complaint, with 361 signatures, was filed in the office of the Board: —

To the State Board of Health of the Commonwealth of Massachusetts.

Respectfully represent the undersigned that they are customers of the Dedham Water Company, a corporation organized under the laws of said Commonwealth, and engaged in the business of supplying water to the town of Dedham and its inhabitants; and they hereby complain that the charges made by said company for water are unreasonable, unfair and inequitable.

Wherefore, they pray that this Board will investigate the charges of said company, and make such recommendations concerning the same as the Board may deem just and proper.

A public hearing was then given by the Board, as required by the act, after notice to the complainants and to the company, and the Board, after investigation of the complaint and a careful consideration of the circumstances, on Feb. 2, 1911, made the following recommendations, modifying the charges for service by the Dedham Water Company: —

To the Dedham Water Company, Dedham, Mass.

GENTLEMEN: — Under the provisions of chapter 319 of the Acts of the year 1909, entitled "An Act to provide for the supervision of water companies by the State Board of Health," this Board is authorized, upon complaint in writing relative to the service furnished in any city or town, or the charges therefor made by any company engaged in the business of supplying water to such city or town or the inhabitants thereof, made by the mayor of the city or selectmen of the town, or by fifty customers of the water company, to give a public hearing to the complainant or complainants and to the company, and to require the company to furnish such information as may be necessary to determine the matters involved in the complaint; and after the hearing the Board is authorized to make such recommendations concerning the reduction, modification or continuation of such charges for service or concerning other matters in the premises as the Board may deem just and proper.

A complaint having been filed with this Board by more than fifty customers of the Dedham Water Company and by the selectmen of the town, alleging that the rates charged for water by said company are unreasonable, unfair and inequitable, the Board has given a hearing to the complainants and to the company, and has been furnished with such information from the records of the company as appeared to be necessary relative to the rates charged for service by the company and with such other facts as related to the matters mentioned in the complaint.

It appears from the accounts of the Dedham Water Company that during the three years 1908, 1909 and 1910, the yearly income from water rates has been in excess of the cost of yearly maintenance by an amount that would include the dividends at 6 per cent., the interest on bonds at five per cent., a reasonable amount for depreciation in value of the works and a surplus beyond these necessary expenditures. Looking back beyond these three years we find no such surplus, but a deficiency. The time in which there has been this favorable balance is too short to enable the Board to decide what arrangement of rates will in future be most reasonable. At present the minimum rate of $6 we regard as reasonable, and it would be reasonable to apply it to both fixture and meter rates. It is evident that unreasonable charges have resulted when made upon the basis of the number of fixtures in houses where the quantity of water used, as shown by meter, is but a small fraction of that charged for on the fixture basis.

It may be anticipated that before many years matters pertaining to water supply in the town of Dedham will be so settled that the payments for water can be nearly, if not quite, upon the quantity actually used, as shown by meter; yet, under the present conditions, while maintaining the meter rates and the fixture rates, as established for 1911, and making the minimum charge under either rate at $6 per annum, we recommend that after March 1, 1911, when the meter rate amounts to more than the fixture rate, the charge be by the meter rate; and when the meter rate amounts to less than the fixture rate, the charge be by the meter rate plus one-fifth of the difference between the meter rate and the fixture rate.

We further recommend that the installation of meters be continued as rapidly as practicable throughout the system.

After making the reduction in receipts resulting from the recommendations herein made it is to be expected that, if receipts from the railroad be continued substantially as in the past three years, the company will be enabled to carry out its avowed policy "to continue a gradual reduction in rates as fast as it can safely do so, and at the same time maintain fair earnings and a high standard of efficiency."

The "reserve contingent fund" upon the books of the company is probably no greater than would properly have been charged to depreciation had the accounts been kept in that form, and no one would contend the company's right to see that from its earnings the value of the property invested is kept unimpaired.

Subsequently, communications were received from the Dedham Water Company making objection to the method proposed for applying the recommendations of the Board relative to modifications of the water rates, and on February 20 the following further communication was addressed to the water company relative to this question: —

To Winslow Warren, Esq., *President, Dedham Water Company.*

Dear Sir: — Your letters of February 7, 9 and 13 have been received and referred to the committee having the matter in charge. The amount of reduction in receipts by the water company following the recommendation of the State Board of Health under date of February 2 appears to be satisfactory to you, but you take exception to the method of applying it and propose another method.

Following the reception of petitions from people and authorities of Dedham, representing that the rates charged for water were unreasonable, unfair and inequitable, the hearing that was granted brought out, as the prominent objection, the unreasonableness of charges based upon the number of fixtures in houses where the quantity of water used, as shown by meter, is but a small fraction of that charged for on the fixture basis.

This Board recognizes this as unfair, and has endeavored to present a method that will make the result fair to the company and to the water takers. The method you propose does not remove this unfairness, and if adopted would leave these objectors in their present strong position to appeal to this Board to have this unfairness removed.

In your letter of February 7 occurs the following: —

> The one-fifth over meter rates proposed in the Board's plan cannot be ascertained until the end of the year, when full meter use can be determined, and then it will be largely non-collectible because of the fact that the occupancy or tenancy of a large part of the houses and buildings in Dedham is a shifting quantity, and occupants or tenants at the end of the year are very different from those at the beginning.

We do not see the necessity of making your settlements yearly. Why not make quarterly settlements, as is common where payments are made on meter readings?

You speak of difficulties in withdrawing the discount already allowed for 1911.

It does not seem to us necessary that any discount should be withdrawn. The reduction in the income of your company which the Board considered reasonable was based upon the excess of your receipts over your expenditures. These receipts on your books included your rates by meter and by fixtures, less the discount for prompt payment, and similar rates are referred to in the award of the Board on page 3, which reads: "while maintaining the meter rates and the fixture rates as established for 1911." These were established with a discount for prompt payment. You are having the use of the money as well as sure payment.

In making the award no mention was made of discount, although that is included in your rates for 1911, for the reason that in the future you might think best to arrange your discount on a three-months' use, instead of on a year's use. In either case you make the discount to insure prompt payment, and, at present, that you may have the use of the money for a large fraction of the year. If your accounts were settled upon reading the meters once in three months, you would doubtless find it for your interest to make a discount for prompt payment, but it would not be at the same figure, because you would not have the use of the money for so long a time and an intelligent view of your own interest would cause you to make it reasonable.

We appreciate that some inconvenience will attend the change of method, whenever it takes place, but we see no insuperable difficulty in beginning immediately and arranging for the charges recommended by the State Board of Health to begin to accrue on the first day of March next.

Very respectfully,

Hiram F. Mills,

Chairman of Committee on Water Supply and Sewerage of the State Board of Health.

The Board is informed that action has been taken by the water company by giving notice of a proposed change in water rates to go into effect on Jan. 1, 1912. The action taken by the company is not in accordance with the recommendations of the Board. The notice is as follows: —

Dedham Water Company. — Change of Water Rates for 1912.

The charges for water for 1912 will be upon the meter basis, with a *minimum payment of six dollars ($6) Jan. 1, 1912,* for single water takers whose faucet rate for 1912 would not exceed eleven dollars ($11) and of *twelve dollars ($12)* for all other single takers.

Where there are several takers upon one meter, the charge for such takers will be upon the above basis, and no charge for excess use will be made until the water used by meter shall exceed amount allowed upon the *total* minimum payments on such meter.

Bills for water used by meter in excess of above minimums will be sent April 1, July 1, October 1 and January 1, and all bills must be paid within twenty (20) days from date, or *water may be shut off upon brief notice.*

The above charges do not apply to special contracts, nor to the high service.

The above rates are in substance those recommended by the State Board of Health, the slight variation being to simplify methods to prevent misunderstanding by the takers, and to avoid complications and delay in settlement.

The meter rates will be somewhat lowered, as follows: —

For first 50,000 gallons or less, 25 cents per 100 cubic feet (748 gallons).
For next 150,000 gallons or less, 23 cents per 100 cubic feet (748 gallons).
For next 100,000 gallons or less, 18 cents per 100 cubic feet (748 gallons).
For next 200,000 gallons or less, 15 cents per 100 cubic feet (748 gallons).
For water in excess of above 500,000 gallons, 10 cents per 100 cubic feet (748 gallons).

$6 will pay for 18,000 gallons, or 2,400 cubic feet.
$12 will pay for 36,000 gallons, or 4,800 cubic feet.

Per order of Directors,
WINSLOW WARREN, *President,*
Dedham Water Company.

DEDHAM, Nov. 15, 1911.

EXAMINATION OF SEWER OUTLETS.

Under the law requiring the annual examination of all main outlets of sewers and drains in the cities and towns of the Commonwealth, and the effect of sewage disposal (chapter 75, section 4, Revised Laws), the sewer outlets of the various cities and towns have been examined, and chemical analyses have been made of the effluents of the sewage-disposal systems and of many of the waters into which sewage is discharged.

OUTLETS INTO THE SEA.

The principal outlet for the sewage of the city of Boston is at Moon Island, where the sewage, after storage in reservoirs, is discharged in the early part of each outgoing tide. With the completion of the high-level sewer of the south metropolitan system about six years ago, the quantity of sewage discharged at this outlet has been less than formerly, amounting in 1911 to about 90,000,000 gallons per day, making the total amount discharged on each tide approximately 45,500,000 gallons, and the rate somewhat more than 22,500,000 gallons per hour while the discharge continues. The sewage after discharge covers an extensive field between Moon Island and Long Island, and ordinarily moves around the southerly side of the latter and between it and Rainsford Island toward Massachusetts Bay, the sewage rapidly dispersing, so that very little evidence of it is noticeable, except in calm weather, for a distance of more than 1½ miles from the outlet. There has been no decided change in the conditions affecting the discharge of sewage at this outlet during the past year.

The sewage of the north metropolitan sewerage district is discharged at a main outlet at the southeasterly end of Deer Island at the entrance of Boston harbor at all stages of the tide. The quantity discharged in

1911 probably averaged about 60,000,000 gallons per day, or 2,500,000 gallons per hour. The sewage is rarely traceable beyond a very limited area within a few hundred feet of the outlet, except for an oily film, which is noticeable on the surface of the water in calm weather for a distance of a mile. The sewage is discharged at approximately the level of the sea at low water, and it is probable that even better results can be secured at this outlet by extending it farther into the channel, very deep water being found within a short distance of the present terminus of the sewer.

The sewage of the south metropolitan district is discharged through a main outlet near Peddock's Island, in the southerly part of the harbor. The quantity of sewage discharged at this outlet in 1911 probably averaged 40,000,000 gallons per day, and as the discharge is continuous, the average discharge per hour was 1,700,000 gallons. While the quantity discharged at this outlet is gradually increasing, the outlet is very difficult to locate, even under the most favorable conditions. In this case the sewage is discharged at the bottom of the sea, where the depth of water is 30 feet at low tide and the sewage becomes very greatly diluted before reaching the surface.

At New Bedford preparations are being pushed forward rapidly for the construction of works for the removal of the sewage of that city, which now causes very serious nuisances in New Bedford harbor and Clark's Cove to a point of discharge into the sea, about 3,600 feet southeast of Clark's Point, where the water is 27 feet in depth at low tide.

At Fall River the sewage of the city is discharged at 12 outlets into the Taunton River and Mt. Hope Bay. These outlets are all located near the shore, the sewers in some cases terminating at or about high-water mark in the river or bay, and the water along the shore in the neighborhood of each of the main outlets, with the exception of one or two at the lower end of the city, where the quantity of sewage discharged is small, is badly polluted and the odor is very offensive. The conditions at most of these outlets are very objectionable, and as the selection of a plan for improving these conditions will involve considerable study, the necessary investigations should be begun as soon as practicable.

At Lynn, where the conditions about the main outlet are very objectionable, investigations have been in progress during the year for the purpose of devising a plan to remove the existing nuisance.

The conditions about the sewer outlet of the city of Salem and town of Peabody, located near Great Haste Island in Salem harbor, have not changed materially since the last examination was made. The outlet is located near the surface of the water at low tide, and the sewage, which contains large quantities of manufacturing waste, chiefly from tanneries and similar works, and which contains more organic matter than is ordinarily found in the sewage of cities and towns, spreads over a wide area before becoming thoroughly diffused with the sea water. An offensive odor is noticeable sometimes at considerable distances from this outlet. It is probable that the objectionable conditions noticeable at times about this outlet could be prevented by locating it in deep water, which can be reached by extending the sewer a distance of about 2,500 feet.

The sewage of the city of Beverly is discharged into Beverly harbor near the edge of the channel off Andrews Court. The outlet is located near a populous shore, a part of which is used as a playground, and along this shore east of the outlet an extensive area of beach and flats is exposed at low water. Examinations during the past year have shown that solid matters from the sewage are deposited upon these flats as the tide recedes. The quantity of sewage discharged at this outlet has increased greatly in recent years and is likely to increase in the future if the growth of the city continues. In view of the conditions, especially the extensive use of the seashore in this region for bathing, it is very desirable for the protection of the public health that the present sewer outlet be discontinued and the sewage removed to some place of disposal where it will be unlikely to create objectionable conditions.

A plan was submitted to the Board Dec. 15, 1908, providing for collecting the sewage of the various parts of the city by means of a system of sewers, pumping stations and force-mains into two main sewers, discharging at an outlet north of Great Haste Island in Salem harbor. Hearings were given on this plan some time ago, but action has been postponed to await the results of further investigations by the city as to a general system of sewage disposal. The selection of a better method for the disposal of the sewage of the city should not be longer delayed.

At the remaining outlets where sewage is discharged into the sea no material change in the conditions has taken place from those reported in previous years.

OUTLETS DISCHARGING INTO RIVERS.

Of the 64 inland cities and towns in the State having systems of sewerage, 32, or one-half, discharge their sewage untreated directly into some inland stream, while the remaining 32 have provided themselves with works for purifying the sewage or subjecting it to some form of treatment for the removal of organic matters before its final disposal. The sewer outlets of those cities and towns which discharge their sewage directly into an inland water without treatment will be considered in connection with the condition of the streams in which the outlets are located.

Following is a list of the cities and towns having works for the purification of a part or all of the sewage before its final disposal:—

Amherst.[1]
Andover.
Attleborough.[1]
Billerica.
Brockton.
Clinton.
Concord.
Easthampton.
Framingham.
Franklin.
Gardner.
Hopedale.
Hudson.
Leicester.
Lenox.
Longmeadow.
Marion.
Marlborough.
Maynard.
Medfield.
Milford.
Natick.
North Attleborough.[1]
Northbridge.
North Brookfield.
Norwood.
Pittsfield.
Southbridge.
Spencer.
Stockbridge.
Westborough.
Worcester.

All of the foregoing systems of sewage disposal have been examined during the year, and in most cases samples of the sewage and effluent are collected for analysis at regular intervals, to aid in the determination of the efficiency of the works. In many cases there has been a decided improvement in the efficiency of the purification of the sewage at these works during the past year, as compared with preceding years, the improvement being especially noticeable at Clinton, Hudson, Marlborough, Natick and Westborough. On the other hand, deterioration has occurred in some cases, due often to the neglect to increase the capacity of the purification works made necessary by the growth of the city or town, but usually to lack of care in the management and operation of the works.

Pollution of the Neponset River.

Under the provisions of chapter 541 of the Acts of the year 1902, as amended by chapter 360 of the Acts of the year 1906, the Board is authorized and directed to prohibit the entrance or discharge of sewage into any part of the Neponset River or its tributaries, and to prevent the entrance or discharge therein of every other substance which may be injurious to public health or may tend to create a public nuisance.

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[1] Constructed in 1911.

The Board is further required to consult with and advise the owner of any factory or other establishment, at his request or of its own motion, as to the best practicable and reasonably available means of rendering the waste or refuse therefrom harmless. The statute further provides that proceedings to enforce any order made by the Board under the act shall be instituted and prosecuted by the Attorney-General upon request of the Board.

Under this act the Board has investigated the sources of pollution of the river, has notified cities, towns and persons causing such pollution to desist therefrom, and has consulted with and advised owners of factories and other establishments as to the best practicable and reasonably available means of rendering the waste or refuse therefrom harmless.

It is probable that, excepting in the town of Stoughton, nearly all of the sewage which was formerly discharged directly into the river or its tributaries has been diverted from the streams. In the town of Stoughton, however, there are a number of sewers and drains in the thickly populated part of the village which evidently receive much sewage, and as these drains are covered and no records of the connections with them are available, the sources of these pollutions are difficult to locate. It is not likely that the sewage entering the streams in this town can be disposed of unobjectionably, unless by means of sewers. There are also several factories in and near the village which discharge considerable manufacturing wastes into the drains and streams, and there does not appear to be any practicable or reasonably available means for disposing of these wastes at or near the factories without danger of creating a local nuisance.

The best practicable plan of preventing the pollution of the tributaries of the Neponset River by sewage and manufacturing waste in and near the thickly settled portions of this town will be to construct a system of sewerage and sewage disposal; and in accordance with the recommendations of the Board the town caused plans to be prepared, and secured from the Legislature of 1911 authority to construct a system of sewerage and sewage disposal. The town has failed, however, during the present year to authorize the construction of works, but has committed the question to a committee of citizens for consideration and a report. So far as the Board is informed, no report had been made by this committee at the end of the year.

By far the most difficult problem in purifying the Neponset River has been the treatment of the manufacturing wastes, which are the most important causes of its pollution. Many of the mills use very large quantities of water in their manufacturing processes, in some cases the quantity used, especially in the upper waters, being a very large proportion, if not the entire flow, of the stream for long periods in years of low rainfall, and it is essential that manufacturers shall return to the river the waters used in their processes for the use of other manufacturers on the stream below. For this reason it is impracticable to collect the wastes by a general system of drains or sewers and purify them at convenient places, or even to collect the wastes from groups of mills in a given locality for combined treatment, except in a few instances.

Many of the factories and mills in the town of Norwood, which has recently completed a system of sewerage and sewage disposal, find it practicable to dispose of their wastes, as well as their sewage, into the town sewers, and, as stated above, a similar plan will be the best method of dealing with the problem of preventing the pollution of the streams in and about the town of Stoughton.

In the lower part of the valley, also, where sewers connected with the metropolitan system are available, it has been practicable to dispose of a limited amount of manufacturing waste, which otherwise would have been very difficult to purify, by discharging it into the sewerage system. In the great majority of cases, however, it is necessary that the wastes shall be treated in the neighborhood of the factories and the effluent returned to the stream in such condition that it will not either alone or when mingled with other effluents be likely to create objectionable conditions.

At practically every factory and mill in the valley, except in the village of Stoughton, works for treating all or a part of the polluting manufacturing wastes have been installed and are in more or less continuous operation. In very few cases, however, are the works thus far built adequate for the efficient purification of the wastes, even under favorable conditions. One of the difficulties in dealing with this problem is the fact that a purification works constructed for the treatment of a given factory waste, even though inadequate for the purpose, will often, for a longer or shorter period, continue to give satisfactory results, especially under favorable conditions of weather and season. After a time the efficiency of the purification begins to diminish, and sooner or later the works become wholly inoperative, making it necessary to discontinue their use until they can again be put in proper condition for another period of use.

In many cases the Board has found it impracticable to secure compliance with the statutes enacted to prohibit the pollution of the river, and has requested action by the Attorney-General.

IMPROVEMENT OF THE NEPONSET RIVER.

The Legislature of 1911 directed the carrying out of the improvement of the Neponset River, for which plans were prepared by the Board in 1897. The act of 1911, entitled "An Act relative to the protection of the public health in the valley of the Neponset River," directs the Board to expend a sum not exceeding $150,000 in constructing the necessary drains, trenches and ditches, and in dredging and deepening the channel of the Neponset River, for the purpose of restoring the lands along the river to their original condition, and to abate malaria and other peril to the public health.

This work was organized late in the year and a corps of engineers engaged to make the necessary surveys and investigations and to prepare detailed plans for the work.

POLLUTION OF STREAMS.

Assabet River.

The condition of the Assabet River below the Westborough filter beds has been very much better than for several years, and the filter beds, recently enlarged, have been in satisfactory operation during the year. A great improvement has also taken place in the effluent discharged from the filter beds used for the disposal of the sewage of the town of Hudson, the filtration area of which has also been increased, but the river below Hudson has shown a steadily increasing pollution for several years, this condition evidently being caused largely by manufacturing waste discharged into the stream at Hudson. The sewerage system was designed to receive the manufacturing wastes, but on account of the admission of wool-scouring waste without preliminary treatment for the removal of fats, the operation of the filters has in previous years been seriously interrupted. Manufacturing waste which is likely to interfere with the operation of the filter beds should not, of course, be admitted to the sewers until the objectionable substances have been removed, but unless the waste is sufficiently purified by the process to admit of its discharge into the stream without danger of causing objectionable conditions, it should either receive further treatment or be discharged with the other sewage upon the filter beds.

Below Maynard the river is grossly polluted, partly by sewage from a few sewers in Maynard but chiefly by great quantities of manufacturing waste discharged from the woolen mills in the town. In 1909 the town and the owners of the mills were notified of the causes of the nuisance, and were advised of the necessity of purifying the sewage and manufacturing wastes discharged into the river. Investigations were then begun by the owners of the mills relative to the suitability of certain areas of land for the disposal of manufacturing waste in the neighborhood of the village. No progress having been made in the relief of the pollution of the river, the Board has again called attention to the very objectionable condition of the river during the past year, and has made a further recommendation that the question of the purification of these wastes should be taken up without delay, many complaints having been received of the offensive condition of the river for a long distance below Maynard. In the latter part of the year the matter was again taken up by the mills, but it does not appear that any definite plan for removing this nuisance has yet been selected.

A small amount of waste finds its way into the river at one or two points below Maynard, including part of the sewage and manufacturing waste from the Concord Reformatory.

Blackstone River.

This stream is badly polluted in its upper waters by sewage and manufacturing waste from a number of mills in the Cherry valley district in Leicester and Worcester, and during the past year the condition of the river became so objectionable that the manufacturers were notified of the results of the examination of the stream and advised to provide means for purifying the sewage and wastes discharged from their mills.

Below the sewage purification works of the city of Worcester the condition of the river shows no important change, as compared with previous years.

Charles River.

The condition of the Charles River below Milford has shown a decided improvement during the past year, as compared with former years, due no doubt to the introduction of sewage disposal works in the town of Milford and the extension of the sewerage system in the town.

At Franklin one of the main tributaries of the river continues to be very badly polluted by sewage and manufacturing waste discharged into the stream in this town.

In the lower portions of its course the condition of the Charles River shows no important change from former years.

Connecticut River.

The condition of the Connecticut River has shown no important change, as compared with previous years. One of the smaller tributaries, the Fort River in Amherst, has shown considerable improvement during the past year, due to the improvement in the disposal of the sewage of that town, which formerly caused the serious pollution of the stream.

The conditions in the Mill River at Northampton have remained about as in the previous year.

The Connecticut River as a whole has not shown as yet a very marked effect of sewage pollution. There are numerous sewer outlets discharging into the river at Turners Falls, South Hadley, Holyoke, Chicopee, Springfield and West Springfield, and the sewage of Greenfield and Northampton is discharged into tributaries at no great distance from the main river. The banks of the river are badly polluted in some places by sewer outlets, which discharge at or near the high-water level and cause the fouling of the shores for considerable distances when the water is low, besides producing offensive odors in the neighborhood. In a few cases pipes have been laid beneath the bottom of the river to outlets located several hundred feet from the shore, and while at times of storm large quantities of dilute sewage are discharged near the banks at the high-water level, these temporary outlets are not seriously objectionable. The condition of the banks of the Connecticut River at many points could be very materially improved by extending the sewer outlets to suitable points of discharge in the current of the river.

French River.

The French River is very badly polluted at several points, especially at Webster, where it receives the entire sewage of the town and all of the wastes from a very large woolen mill, including much waste from the process of scouring wool. The condition of the river has been growing worse for several years, and is seriously objectionable at the present time at points below the town.

Hoosick River.

There have been no material changes in the condition of the Hoosick River, which is very badly polluted by the discharge into the stream at various points of the sewage of Adams, North Adams and Williamstown. At the point where the river flows into the State of Vermont at Williamstown, the pollution has been much greater than in the previous year.

The town of Adams has begun the construction of a sewerage system, the plans for which include a provision for purifying the sewage upon land in the valley below the town.

It was noted last year that investigations were in progress relative to plans for purifying the sewage of the city of North Adams, which is the chief factor in the pollution of the stream at the present time, but the work appears to have been discontinued.

Judging from the experience of the past three years it is unlikely that material progress will be made in the improvement of the condition of this river unless the cities and towns chiefly responsible for its offensive condition shall be required to take measures for its relief. The preparation of satisfactory plans for the collection and disposal of the sewage will require considerable time, and much further time will be consumed in the construction of the works. Even if the work should be begun at once and carried on with diligence, several years must elapse before the river can be relieved of a considerable portion of the pollution which now makes it offensive, and in the meantime its condition is likely to become much worse than it is at present.

Housatonic River.

The city of Pittsfield and the towns of Lenox and Stockbridge in the valley of the Housatonic River maintain sewage-disposal works for the treatment of their sewage before its discharge into the Housatonic River. On the other hand, the towns of Dalton, Lee and Great Barrington discharge all of their sewage directly into the river without treatment.

The Pittsfield sewage-disposal works are well managed and are among the most efficient in operation of any in the State, but a large part of the sewage of the city is not treated at the disposal works, but is allowed to overflow into the river at or near the pumping station. Two other sewers were discharging large quantities of sewage into the river at the time of a recent examination.

The sewage-disposal works at Lenox is not used for the treatment of all of the sewage of that town, and small quantities of sewage are discharged into the stream in other places.

One of the chief pollutions of the stream is the manufacturing wastes, principally from woolen and paper mills located at various points along the main river and its tributaries in Hinsdale, Dalton, Pittsfield and Lenox.

Analyses of the water of the river and its principal tributaries show that they are badly polluted at many points, especially in and for a considerable distance below the city of Pittsfield.

Millers River.

The Millers River below Winchendon shows considerable increase in pollution, as compared with a former examination. There has also been an increase in the pollution of the Otter River below Gardner. Below

Athol the quantity of organic matter has been greater than in former years, and the same condition is found at Orange, at both of which towns the sewage is discharged directly into the river without treatment. The effect of the pollution of the river is increasingly noticeable in the analyses of samples taken at the mouth of the stream. While the pollution of this river is increasing quite rapidly, its condition has not yet become such as to be seriously objectionable at any point in the main portion of its course. Reconstruction of the filters at Gardner has resulted in a marked improvement in the efficiency of the purification of the sewage of that town in the latter part of the year.

Nashua River.

The north branch of the Nashua River has for many years been grossly polluted by the sewage of the city of Fitchburg and town of Leominster, and its condition in the portions of its course below those places has been worse than in any previous year. Works for the construction of a trunk sewer have been begun by the city of Fitchburg under a plan which provides for the removal of the sewage from the river and its purification upon filter beds located near the river below the city. From the report of the sewage-disposal commission, under the provisions of chapter 461 of the Acts of the year 1910, dated July, 1911, it appears that the work of constructing the sewerage system of the city is well under way, and a large area of land has already been acquired with a view to the construction of filter beds for the purification of the sewage, in accordance with plans proposed by the city of Fitchburg and approved by the Board in 1903.

Plans of works for purifying the sewage of the town of Leominster were made several years ago, but no action has yet been taken looking to the carrying out of those plans. Monoosnock Brook in this town is very badly polluted by sewage and manufacturing waste before it joins the north branch of the Nashua River. It is important that the construction of sewage-disposal works shall be begun by this town without further delay, in order that they may be completed by the time the Fitchburg works are ready for operation, and relieve the river of the great pollution to which it is now subjected.

The effect of the pollution of the north branch of the Nashua River at Fitchburg and Leominster has been increasingly noticeable at the junction of the north and south branches at Lancaster during the past year, the quantity of organic matter in the water of the north branch at this point, as shown by the analyses, being much greater than ever before.

The south branch of the Nashua River below Clinton, but above the

Clinton sewage purification works, shows evidence of marked increase in pollution in the last two years, due probably to the discharge of manufacturing waste into the stream at the mills in the town. The pollution is slightly less at the mouth of the river below the purification works than at points above, but has been greater at that point than in former years.

At the village of Still River on the main stream below the junction of the north and south branches, the water shows evidence of increased pollution, as compared with former years, and a similar result is shown by the observations at Pepperell, below which the stream flows into the State of New Hampshire.

Sudbury River.

The Sudbury River is very badly polluted by manufacturing wastes discharged from the woolen mills at Saxonville in the town of Framingham. During the past year investigations were begun for the purpose of devising a sewerage system for this portion of the town, and the question of the disposal of the manufacturing waste from the Saxonville mills is being considered in connection with that plan.

Taunton River.

One of the chief tributaries of the Taunton River, the Salisbury Plain River, has been the source of much complaint in the town of East Bridgewater, the cause of which has been ascertained to be the discharge into the stream of polluting matters in the city of Brockton. The sources of this pollution have been ascertained by the Board, and efforts made for its prevention have resulted in a considerable improvement in the river in the latter part of the year.

The Town River, another tributary of the Taunton, is considerably polluted by sewage and manufacturing wastes discharged into the stream in Bridgewater, and another tributary, the Nemasket River, is badly polluted by the direct discharge into the stream of all of the sewage and manufacturing waste of the town of Middleborough. The sewer outlets of this town are among the most offensive to be found in the State.

Late in the year complaint was made of the pollution of the Three Mile River, a stream flowing through Norton, Taunton and Dighton to the Taunton River at Taunton. An investigation having shown that this stream is grossly polluted by manufacturing waste, especially below a wool-scouring mill in the town of Norton, notice has been given of the necessity for treating the wool-scouring wastes from this establishment, and the treatment of wastes from other polluting sources, in order to remove the existing causes of complaint.

The sewage of Taunton is discharged untreated into the Taunton River in the lower part of the city, under authority of chapter 268 of the Acts of the year 1897, under which authority was given to discharge the sewage temporarily into the river during the construction of the works. Upon a petition of the city in 1910 for a further extension of the time for completing the system and removing the sewage to the place of final disposal selected in the town of Berkley, a careful examination of the river was made and the time for the removal of the sewage from the river extended to Dec. 1, 1913. The time within which a further study of the most efficient and economical method of sewage disposal should be made by expert engineers, and plans presented to the State Board of Health, including the preparation of working plans for construction, was limited to Dec. 1, 1911. The terms of this extension do not appear to have been complied with.

Ten Mile River.

This stream has heretofore been very badly polluted by sewage and manufacturing wastes in the towns of North Attleborough and Attleborough, but during the past year the sewage purification works of the town of North Attleborough have been completed and the works of the town of Attleborough have been so far advanced that they are likely to be completed early in the coming year. With these works in operation it will be practicable to divert the sewage from the river and prevent its further serious pollution.

Ware River.

The Ware River, as noted in former years, has been very badly polluted by the refuse from a wool-combing plant at Barre, in the upper waters of the river, and by the discharge of sewage and manufacturing waste at other points in its course, but particularly at Ware, where all of the sewage of the town, including large quantities of manufacturing waste, is discharged untreated into the stream. At Barre works have been installed recently for treating the wool-scouring waste before its discharge into the river, but nevertheless the condition of the stream has been worse than in the previous year. Some slight improvement is shown in the condition of the river farther down-stream, but it still remains very badly polluted throughout the greater part of its course.

Westfield River.

The Westfield River is used as a sewer outlet by the town of Westfield and as a place of disposal of a portion of the sewage of the towns of Agawam and West Springfield, the chief pollution being that caused by the discharge of the sewage of Westfield into the river at a point about 10 miles from its mouth. The effect of this sewage on the condition of the stream, though increasingly noticeable from the chemical analyses, has not yet become such as to be seriously objectionable at points below. The quantity of sewage discharged at West Springfield and Agawam is as yet comparatively small and has little noticeable effect upon the river. The stream is also polluted by manufacturing wastes, chiefly from paper mills at various points along its course, but its condition is not at any point very seriously objectionable at the present time.

Other Streams.

The Deerfield River receives comparatively little pollution at any point in its course, and its condition shows no material change from former years.

The Green River, one of the principal tributaries of the Deerfield, is very badly polluted by the sewage of Greenfield, and works are now under construction for the removal of the sewage to a point near the Deerfield River, where, after settling and screening, the sewage is to be discharged into the river.

The condition of the Quinebaug River below Southbridge shows no material change as compared with former years, and the same is true of the Swift and Quaboag rivers, two of the principal tributaries of the Chicopee.

EXAMINATION OF MERRIMACK RIVER.

Under the provisions of chapter 505 of the Acts of the year 1909 the Board is directed to examine the bed, banks and waters of the Merrimack River and the streams tributary or adjacent thereto, at such times as it may deem proper, and whenever it shall determine that the condition of the river or its banks is injurious or dangerous to the public health or likely to become dangerous or injurious to the public health, by reason of the entrance of sewage or refuse from factories or other causes, to prepare a plan or plans for removing the cause of such injury or danger and report the same to the General Court. Under this act the Board instituted a careful inspection of the river in connection with which stations were established at which samples of water are collected at frequent intervals for chemical analysis, and has examined the sources of its pollution, especially the manufacturing wastes and sewage discharged into the river in the various cities and towns, and their effect upon the condition of the bed, shores and waters of the river. The numerous sewer outlets discharging into the stream have all been carefully examined, and where the conditions are found objectionable or likely to become injurious to the public health, plans are being prepared for the proper disposal of the sewage. The most difficult part of the problem is the determination of the effect of the various manufacturing wastes upon the river, and the kinds of manufacturing waste which are most objectionable in their effects upon the streams, and especially the selection of practicable methods by which these wastes can be collected and so treated as to prevent their causing further injury to the stream. These studies are in progress and plans for carrying out this work are being prepared as rapidly as practicable.

LAWRENCE EXPERIMENT STATION.

The investigations at the Lawrence Experiment Station during the year have included the operation of 11 different filters in studies of the purification of water, and of 47 different filters in studies of the purification of sewage.

In the investigations of water purification special study has been made of slow sand filters operated at widely different rates, particularly with reference to economy of operation and to the quality of the filtered water. Studies of the purification of water by precipitation with sulphate of alumina, followed by filtration at a high rate through a mechanical filter, and after treatment in a high-rate preliminary or roughing filter, have been continued, and studies have been made of the efficiency of an upward-flow roughing filter of coarse material and of a sprinkling filter constructed of sand. The investigation of the influence of various methods of water purification upon the action of water on metal pipes and plumbing fixtures has been continued throughout the year.

The investigations upon the purification of sewage have included the operation of sand filters which have been in continuous operation for over twenty years, and of contact filters and trickling filters which have been in operation for ten and twelve years, respectively. These long-continued studies are particularly valuable as they show clearly the ultimate destruction or disappearance of large amounts of organic matter deposited by the sewage and retained within the filter for long periods. Special study has also been made during the past year of the methods of operation of contact filters to determine the effect of applying the sewage in different ways, of different periods of contact and of different rates, upon the degree of purification accomplished and upon the capacity and length of life of such filters. Studies of the preliminary clarification of sewage by chemical precipitation, by straining and by sedimentation in open tanks and in tanks filled with slate are also in progress, and special attention has been given to the effect of these various preliminary treatments on the subsequent purification of the sewage upon sand filters. A further investigation of certain factors controlling the rate of operation of sand filters is under way, and an extensive investigation has also been made to determine the effect of carbonaceous matter of different kinds in sewage upon the processes of nitrification in sand filters. Studies of the disposal of manufactural wastes have been continued, and filters have been operated with the wastes from a tannery and from a rubber mill.

In the chemical laboratories an extensive investigation is in progress upon the composition of sewage sludge and manufactural wastes, particularly with reference to the recovery of valuable by-products, or to their use in the manufacture of fertilizers. In addition, a large number of analyses of water and factory wastes have been made in connection with the investigation of the pollution of rivers.

As in previous years, all the bacterial work of the department of water supply and sewerage has been carried on at the experiment station, and a large number of bacterial examinations have been made of samples of water, sewage, ice and of shellfish. In connection with the shellfish examinations, studies are in progress looking to improvements in the bacterial methods and to more accurate interpretation of the analytical results. In addition, an extended investigation has been made of the character of the air in different branches of the textile industry, and of the effect of the quality of water used in supplying artificial humidity to the air upon the bacterial content of such air.

CHANGES IN LEGISLATION WHICH AFFECT THE WORK OF THE STATE INSPECTORS OF HEALTH.

During the Legislative session of 1911 the following acts were passed: —

A. Acts specifically referring to the Health Districts and the State Inspectors of Health.

1. Relative to the inspection of jails, houses of correction, prisons and reformatories.
2. Relative to obtaining information concerning the proper lighting of factories and workshops, and investigating eye injuries.
3. Relative to the health districts and to the inspectors of health of the Commonwealth.

B. Other Acts.

1. Relative to the maintenance of isolation hospitals by cities and towns.

2. Relative to the maintenance of tuberculosis dispensaries in cities and towns of 10,000 inhabitants or over.

3. Relative to the furnishing of drinking water on passenger trains (previously referred to, see page 8).

4. Relative to the appointment of inspectors of slaughtering (previously referred to, see page 9).

5. Relative to prohibiting the use of suction shuttles in factories. This act takes effect on the first Monday in May in the year 1912.

They are as follows: —

ACTS OF 1911, CHAPTER 282.

AN ACT RELATIVE TO THE INSPECTION OF JAILS, HOUSES OF CORRECTION, PRISONS AND REFORMATORIES.

Be it enacted, etc., as follows:

SECTION 1. Chapter four hundred and five of the acts of the year nineteen hundred and ten is hereby amended by striking out section one and inserting in place thereof the following: — *Section 1.* The state inspectors of health, in addition to the duties provided for by chapter five hundred and thirty-seven of the acts of the year nineteen hundred and seven, shall annually make such examination of police station houses, lockups, houses of detention, and, except in the county of Suffolk, jails, houses of correction, prisons and reformatories as in the opinion of the state board of health may be necessary to ascertain the sanitary condition of the said buildings.

SECTION 2. Said chapter four hundred and five is hereby further amended by striking out section two and inserting in place thereof the following: — *Section 2.* The state board of health shall make rules for police station houses, lockups, houses of detention, jails, houses of correction, prisons and reformatories, regarding the care and use of drinking cups and of dishes used for food, the care and use of bedding, and the ventilation of the buildings. Such rules may be general or may be applicable to a single building. A copy of such rules as are made applicable to station houses, houses of detention or lockups, shall be sent by the state board of health to the mayor of every city and to the selectmen of every town to which the rules apply; and a copy of such rules as are made applicable to jails, houses of correction, prisons or reformatories, shall be sent by said board to the proper authorities. It shall be the duty of the mayors of cities and the selectmen of towns to which the rules relating to station houses, houses of detention or lockups so made apply, and the duty of those in charge of jails, houses of correction, prisons and reformatories, to which the rules so made apply, to see that the rules are enforced. [*Approved April 13, 1911.*

ACTS OF 1911, CHAPTER 603.

AN ACT RELATIVE TO OBTAINING INFORMATION CONCERNING THE PROPER LIGHTING OF FACTORIES AND WORKSHOPS AND INVESTIGATING EYE INJURIES.

Be it enacted, etc., as follows:

SECTION 1. The state inspectors of health, or such other officers as the state board of health may from time to time appoint, shall, when obtaining information concerning the proper lighting of factories, workshops and other industrial establishments, make such investigation concerning the eye and vision in their relation to diseases of occupation, including injuries to the eyes of the employees, and to the pathological effects which are produced or promoted by the circumstances under which the various occupations are carried on, as, in the opinion of said board is practicable, and the board shall from time to time issue such printed matter containing suggestions to employers and employees for the protection of the eyes of the employees as it may deem advisable.

SECTION 2. If it appears to an inspector of health, or other officer appointed by said board, that in any factory, workshop or other industrial establishment, from the nature of the work or of the machinery used in connection therewith, or of other circumstances, there is danger of injury to the eyes of employees engaged in such work, and that the danger of injury may be decreased or prevented by any mechanical device or other practicable means, he shall, if said board so directs, order in writing that such device or other means shall be provided therein; and it shall be the duty of the proprietors and managers of the factory, workshop or other industrial establishment to comply with the order.

SECTION 3. Any person, firm or corporation violating any provision of this act shall be subject to a fine of not less than five nor more than two hundred dollars for every week during which such violation continues: *provided, however,* that a criminal prosecution for any violation hereof shall not be begun unless such person, firm or corporation shall, for a period of four weeks after the receipt of an order in writing from a state inspector of health or other officer, as provided in the preceding section, neglect to comply therewith.

SECTION 4. There shall annually be appropriated from the treasury of the commonwealth a sum not exceeding one thousand dollars, which sum shall be added to the sum provided for by section seven of chapter five hundred and thirty-seven of the acts of the year nineteen hundred and seven. [*Approved June 30, 1911.*

ACTS OF 1911, CHAPTER 709.

AN ACT RELATIVE TO HEALTH DISTRICTS, AND TO INSPECTORS OF HEALTH OF THE COMMONWEALTH.

Be it enacted, etc., as follows:

The state board of health for the purpose of gathering all information possible concerning the prevalence of tuberculosis and other diseases dangerous to the public health and of carrying out the provisions of chapter five hundred and thirty-seven of the acts of the year nineteen hundred and seven, and of acts in amendment thereof, may expend out of the treasury of the commonwealth annually for salaries and other expenses, in addition to the sum now authorized, a sum not exceeding six thousand dollars. [*Approved July 15, 1911.*

ACTS OF 1911, CHAPTER 613.

AN ACT RELATIVE TO THE MAINTENANCE OF ISOLATION HOSPITALS BY CITIES AND TOWNS.

Be it enacted, etc., as follows:

SECTION 1. Chapter seventy-five of the Revised Laws is hereby amended by striking out section thirty-five and inserting in place thereof the following: — *Section 35.* Each city and town shall establish and constantly maintain within its limits one or more isolation hospitals for the reception of persons having diseases dangerous to the public health as defined by the state board of health, including a tuberculosis hospital or tuberculosis wards. Plans for the construction of such hospitals shall be approved by the state board of health, and said hospitals shall be inspected by the state board of health or by its accredited agent, at least twice in every year. But if, in the opinion of the state board of health, two or more adjoining towns or a city and contiguous towns can advantageously establish and maintain such hospitals in common, the authorities of said towns or of such cities and contiguous towns may enter into such agreements as may be necessary for the establishment and maintenance of the same. Any city or town which upon the request of the state board of health refuses or neglects to comply with the provisions of this section shall forfeit not less than five hundred dollars for every such refusal or neglect.

SECTION 2. This act shall take effect upon its passage. [*Approved June 30, 1911.*

ACTS OF 1911, CHAPTER 576.

AN ACT RELATIVE TO THE MAINTENANCE OF TUBERCULOSIS DISPENSARIES IN CITIES AND TOWNS OF TEN THOUSAND INHABITANTS OR OVER.

Be it enacted, etc., as follows:

Every city, and every town containing a population of ten thousand or more, as determined by the latest United States census, shall establish and maintain within its limits a dispensary for the discovery, treatment, and supervision of needy persons resident within its limits and afflicted with tuberculosis, unless there already exists in such city or town a dispensary which is satisfactory to the state board of health. The said dispensaries shall be subject to the regulations of the boards of health of the cities or towns in which they are respectively situated. A city or town subject to the provisions of this act which, upon the request of the state board of health, refuses or neglects to comply with the provisions hereof, shall forfeit not more than five hundred dollars for every such refusal or neglect. [*Approved June 22, 1911.*

Acts of 1911, Chapter 281.

An Act to prohibit the Use of Suction Shuttles in Factories.

Be it enacted, etc., as follows:

Section 1. It shall be unlawful for any proprietor of a factory or any officer or agent or other person to require or permit the use of suction shuttles, or any form of shuttle in the use of which any part of the shuttle or any thread is put in the mouth or touched by the lips of the operator. It shall be the duty of the state board of health to enforce the provisions of this act.

Section 2. Violations of this act shall be punished by a fine of not less than fifty dollars for each offence.

Section 3. This act shall take effect on the first Monday of May in the year nineteen hundred and twelve; but if the proprietor or manager of a factory shall, in good faith, show to the state board of health sufficient reasons for its inability to comply with the provisions hereof at the time when this act is to take effect, the said board may, in its discretion, grant a reasonable extension of time within which the said factory shall comply with the provisions hereof. [*Approved April 13, 1911.*

THE STATE BOARD OF HEALTH TO MAKE ANALYSES OF PAINT, TURPENTINE AND LINSEED OIL IN CERTAIN CASES.

Acts of 1911, Chapter 218.

An Act to require the State Board of Health to make Analyses of Paint, Turpentine and Linseed Oil in Certain Cases.

Be it enacted, etc., as follows:

Section 1. The state board of health shall make, free of charge, a chemical analysis of paint, turpentine or linseed oil, or any synthetic substitute for any of the said articles, or any preparation containing the same, when submitted to it by the chief of the district police; and the board shall furnish to the said chief a certificate of the analysis, which shall be prima facie evidence of the composition and quality of the materials so analyzed.

Section 2. This act shall take effect upon its passage. [*Approved March 28, 1911.*

LAW RELATIVE TO MEDICAL MILK COMMISSIONS.

ACTS OF 1911, CHAPTER 506.

AN ACT TO AUTHORIZE THE INCORPORATION OF MEDICAL MILK COMMISSIONS.

Be it enacted, etc., as follows:

SECTION 1. For the purpose of supervising the production of milk intended for sick room purposes, infant feeding, use in hospitals and for other uses, any five or more physicians, duly authorized to practice medicine under the laws of this commonwealth may form a corporation in the manner provided by and subject to the provisions of chapter one hundred and twenty-five of the Revised Laws. The members of the board of health of any city or town in which such corporation is formed shall be ex officiis members of the corporation.

SECTION 2. The name of any corporation organized under the provisions of this act shall be "Medical Milk Commission of ", designating the name of the city or town in which such corporation is established, and in case more than one corporation shall be organized under this act in any city or town the subsequent corporation or corporations shall use the name designated herein, but shall indicate in such name its proper sequence in incorporation by adding thereto the words "Number Two" or "Number Three" or as the case may be.

SECTION 3. No member of any corporation organized under this act shall receive directly or indirectly from such corporation, or from any dairyman or dairymen producing milk under agreement with the corporation, any salary or emolument or any compensation of any kind for any services rendered as a member of such corporation, or for any services rendered under the provisions of this act; and any member of such a corporation who shall receive any salary, emolument or compensation of any kind for such services shall be liable to a fine of one hundred dollars, and in addition thereto he shall be removed from his office as a member of said corporation and shall thereafter be disqualified from becoming a member of any corporation incorporated under the provisions of this act.

SECTION 4. Every corporation organized under this act shall have power to enter into agreements in writing with any dairyman or dairymen for the production of milk under the supervision of such corporation for the purposes named in section one and to prescribe in such agreements the conditions under which such milk shall be produced, which conditions, however, shall not fall below the standards of purity and quality for certified milk as fixed by the American Association of Medical Milk Commissions and the standards for milk now or hereafter fixed by the laws of the commonwealth.

SECTION 5. The working methods of any corporation organized under this act and the dairies in which milk is produced under contract with any such corporation shall at all times be subject to investigation by the state board of health.

SECTION 6. No person, firm, association or corporation shall sell or exchange, or offer or expose for sale or exchange as and for certified milk any milk which does not conform to the regulations prescribed by and bear the certification of a corporation organized under the provisions of this act. Any person, firm, association or corporation violating any provision of this section shall be guilty of a misdemeanor, and shall be liable to a fine of not more than one hundred dollars for each offence.

(This bill, returned by the governor to the senate, the branch in which it originated, with his objections thereto, was passed by the senate May 22, and, in concurrence, by the house of representatives May 31, the objections of the governor notwithstanding, in the manner prescribed by the Constitution; and thereby has the "force of a law".)

Typhoid Fever.

On April 14, 1911, the Legislature passed a resolve increasing the general appropriation of the Board by $1,500, in order that the study of typhoid fever in the State might be more thoroughly carried out. To this end the entire services of Mr. Henry N. Jones as bacteriologist have been secured. It is the purpose of the Board to send out, for the use of physicians throughout the Commonwealth, outfits, through the use of which the presence of typhoid bacilli may be detected not only in the blood but also in the stools, the urines and sputum.

A pamphlet on the "Control of Typhoid Fever," prepared by the secretary of the Board, has been sent to all the physicians of the Commonwealth, and this same pamphlet will be sent, beginning with the first of the year (1912), to all households in which typhoid fever is reported.

The practice of antityphoid inoculation is one which is being taken up with enthusiasm in many States and cities of the country, and it is one which should in every way receive the sanction of the State Board of Health of Massachusetts. The Board could furnish to physicians of the Commonwealth at comparatively small expense the typhoid material essential to antityphoid inoculation, and to this end the Board, therefore, recommends that section 4 of chapter 75 of the Revised Laws be so amended as to permit the production and distribution not only of antitoxin and vaccine lymph, but also of specific material for protective inoculation against typhoid fever and such other diseases as may from time to time, in the opinion of the Board, seem advisable.

Ophthalmia Neonatorum.

During the year 1911 the State Board of Health, in co-operation with the Massachusetts Commission for the Blind, has continued its campaign against ophthalmia neonatorum, and it is gratifying to be able to report that very considerable progress has been made in stamping out this disease. In this work the State Inspectors of Health have been of the greatest assistance, and during the year have investigated personally 325 cases of this disease.

In this investigation the method of procedure has been somewhat as follows: on the receipt of a report of a case of ophthalmia neonatorum, the State Inspector of Health for the city or town in which the case occurred has been notified immediately by telephone or by telegraph of the name and address of the patient. On the receipt of this report the State Inspector of Health has informed himself, at the earliest possible moment, as to what was being done by the parents, the attending physician or the local board of health for the cure of the disease, and for the prevention of its very serious after effects.

In case it has been found that the attending physician has been remiss in reporting a case of ophthalmia neonatorum, a special letter has been sent to him by the secretary of the Board reminding him of his duties under the law. Another letter has been sent to the local board of health calling its attention to the infraction of the law by the offending physician, and recommending that appropriate action be taken. In case, furthermore, that the course of the disease has been found to be unfavorable, the State Inspector of Health has made every effort to have the case transferred to the Massachusetts Charitable Eye and Ear Infirmary, or some other hospital of good reputation. That there has been great laxity in the past in reporting this disease has been shown through the effect produced by several prosecutions brought by the Boston board of health.

It is the unanimous opinion of all who have been connected with this work — the Massachusetts Commission for the Blind, the State Inspectors of Health, local health officials, ophthalmologists and social workers — that even though the number of cases reported has been very much increased because of the active campaign which has been waged, the percentage of severe cases has been very much reduced, and it really seems that it is not too much to hope that, with a continued campaign against this disease, blindness from ophthalmia neonatorum may be, within the next decade, practically eliminated from the Commonwealth. Details concerning the work of the State Inspectors of Health in this department will be found in the Supplement.

Outbreaks of Infective Diseases.

Infantile Paralysis.

During the year 1911 the State Board of Health has continued its investigation of the disease known as anterior poliomyelitis or infantile paralysis, and has been greatly assisted in this work by the generous appropriation, by the Legislature of 1911, of $10,000. The general field work has been carried out by Dr. Philip A. E. Sheppard, and several special lines of research have been pursued by Mr. Charles T. Brues of the department of entomology in Harvard University, who has made a general study of insects as possible factors in the transmission of the disease; by Dr. John W. Hammond, Jr., who has studied the blood changes in patients at different stages of the affection; and by Dr. Benjamin E. Wood, who made an investigation as to the prognosis in the disease as shown by the outcome of the cases which occurred in 1907. The researches, furthermore, of Drs. Rosenau, Sheppard and Amoss as to the possible infectiousness of the secretions of the nose and mouth although they have been of a negative character in their results, have been of great importance. A detailed report of the various investigations will be found in a special pamphlet.

The work of the Board in the investigation of this disease, as shown by this pamphlet, has been of a character to draw expressions of approval from persons interested in this disease in all parts of the world. It is the purpose of the Board to pursue this investigation further in 1912, although the exact lines of work will be varied, undoubtedly, from those pursued in the past, and for this purpose it is earnestly recommended that an appropriation be voted by the Legislature of at least $5,000.

Tonsillitis in Boston and Vicinity.

A severe epidemic of tonsillitis in Boston and vicinity took place in the early part of 1911. This epidemic was definitely traced to the milk of a certain contractor as the original source of the outbreak. Details of this epidemic will be found in the Supplement.

Typhoid Fever.

An outbreak of typhoid fever in the town of Attleborough was investigated by the State Inspector of Health for that district, Dr. Elliott Washburn, and the source of this epidemic was very definitely traced to a case of typhoid fever upon a milk farm. Details concerning this outbreak will be found in the Supplement.

POISONING BY INSECTICIDES CONTAINING COMPOUNDS OF FLUORINE.

In view of the fact that a number of cases of sickness and death have been reported as due to the accidental ingestion of insecticides containing compounds of fluorine, it is recommended that appropriate legislation be enacted looking to the prevention in the future of a recurrence of such poisoning.

PROPRIETARY MEDICINES.

During the year 5 proprietary preparations containing alcohol, and with no statement or an incorrect statement as to the percentage of alcohol, were advertised as unsalable at retail, under the provisions of chapter 386 of the Acts of 1906, namely: —

Vino Sangre: Medicinal Wine. S. S. Pierce Company, importers and grocers, Boston, Mass. (No statement as to presence of alcohol.)

Macdonald's Astringent Hair Tonic for Dandruff and Hair Loss. Manufactured by Macdonald Toilet Specialty Company, Detroit, New York and Toronto. (No statement of the percentage of alcohol.)

Milk Cordial-Panna Cream: A Health Tonic. Prepared by Prof. Antonio Alai, Suterville, Pa. (Incorrect statement of the amount of alcohol.)

Thymo-Septol (a useful antiseptic and disinfectant liquid for external and internal uses). Manufactured only by McLaughlin & Dennison, prescription druggists, 417 Main Street, Woburn, Mass. (No statement as to the presence of alcohol.)

Maltol (Dr. Hoff's Favorite Prescription). Exclusive right to manufacture this preparation is controlled only by McLaughlin & Dennison, prescription druggists, 417 Main Street, Woburn, Mass. (No statement as to the presence of alcohol.)

The following preparation was also advertised as unsalable at retail, under the provisions of chapter 386 of the acts of 1906: —

Robbins' Headache Powders. Prepared by McLaughlin & Dennison, 417 Main Street, Woburn, Mass. (No statement as to the presence of phenacetine.)

STATE BOARD OF EXAMINERS OF PLUMBERS.

At a meeting of the State Board of Health, held on July 6, 1911, Mr. James C. Coffey was reappointed to the State Board of Examiners of Plumbers.

A detailed report of the work carried on by this Board in 1911, together with the recommendations for legislation appears in the Supplement.

FOOD AND DRUG INSPECTION.

The number of samples of foods and drugs collected and examined during the year ended Nov. 30, 1911, was 7,283, and the total number since the work was begun in 1882 has now reached 205,708.

During the year 161 prosecutions were made in the various courts of the Commonwealth, bringing the total number to 3,990. The details are presented in the Supplement.

INSPECTION OF LIQUORS.

The work of the Board in connection with the duties of the office of inspector and assayer of liquors, transferred to the Board in 1902, is reported upon in the Supplement.

INSPECTION OF DAIRIES.

During the year ended Nov. 30, 1911, 2,069 dairies were examined by the Board's veterinarian, and the attention of 737 proprietors and of boards of health of cities and towns, wherein the dairies were situated or the product thereof sold, was called to a total of 2,645 objectionable conditions.

Of the total number of dairies examined, 2,067 were situated in Massachusetts and 2 in neighboring States. The details will be found in the Supplement.

Reports upon Fatality of Certain Diseases, Official Returns of Deaths in Cities and Large Towns, the Vital Statistics of the State, the Production, Distribution and Use of Diphtheria Antitoxin and Vaccine, and upon Bacteriological Diagnosis are presented in the Supplement.

ROUTINE WORK OF THE BOARD.

Statistical Table for the Year ended Nov. 30, 1911.

Whole number of samples of food and drugs examined,	7,283
Samples of milk examined (included in the foregoing),	4,690
Number of prosecutions against offenders during the year,	161
Number of convictions during the year,	147
Amount of fines imposed,	$4,015.91
Number of dairies examined,	2,069
Number of packages of antitoxin of 1,500 units each issued to cities and towns,	96,522
Number of tubes of vaccine issued to cities and towns,	65,251
Number of bacterial cultures made for diagnosis of diphtheria in cities and towns,	4,368
Number of examinations made for diagnosis of tuberculosis,	2,383
Number of examinations of blood made for diagnosis of malarial infection,	51
Number of examinations of blood made for diagnosis of typhoid fever,	1,015
Number of nitrate of silver solution outfits for use in cases of ophthalmia neonatorum, issued to cities and towns,	949
Number of notices of cases of infectious diseases received and recorded under the provisions of chapter 75, section 52, Revised Laws,	47,308

Force employed in the General Work of the Board.

Secretary,	1
Assistant to the secretary,	1
Clerks,	5
Messengers,	2
Sanitary inspector of dairies,	1
Health District Act: —	
State Inspectors of Health,	14
Assistants to the State Inspectors of Health,	3
Clerks,	3
Total,	30

Force employed for food and drug inspection: —	
Chemists and assistants,	4
Inspectors,	4
Total,	8

Force employed at laboratory (Bussey Institution): —	
Pathologist,	1
Expert assistants,	2
Stable helpers,	7
Total,	10

Under the Provisions of Sections 112 to 118 of Chapter 75, Revised Laws.

Applications for advice from cities, towns and others: —	
Relating to water supply,	130
Relating to ice supply,	6
Relating to sewerage and drainage,	21
Relating to pollution of streams,	6
Miscellaneous,	13
Total,	176

Number of samples of water, ice and sewage examined chemically at the laboratory, Room 502, State House,	7,238
Number of samples of water, ice and sewage examined microscopically at the laboratory, Room 502, State House,	2,641
Number of samples of water, sewage and ice examined chemically and bacterially at the Lawrence Experiment Station,	2,633
Number of samples of water, sewage, etc., examined bacterially only,	2,622
Number of samples of water, sewage and manufactural wastes examined chemically only,	2,664

Number of samples of sand examined chemically and mechanically,	33
Number of samples of sand examined chemically only,	68
Number of samples of sand examined mechanically only,	44
Number of samples of oysters, clams and quahaugs examined,	93
Number of samples of air examined physically and bacterially,	228
Total number of samples examined,	18,264

Force employed at Central office: —		
Chief engineer,	1	
Assistant engineers,	11	
Stenographers and clerks,	4	
Messenger,	1	
		17
Force employed at laboratory, Room 502, State House: —		
Chief chemist,	1	
Assistant chemists,	7	
Biologist,	1	
Stenographer and clerks,	2	
		11
Force employed at Lawrence Experiment Station: —		
Assistant chemists,	2	
Bacteriologists,	2	
Other assistants and laborers,	3	
		7
Total ordinary force,		35

The number of applications for advice under the provisions of the acts relating to water supply and sewerage, received since July, 1886, when these acts first went into operation, is as follows: —

1886,	8	1900,	104
1887,	22	1901,	105
1888,	28	1902,	93
1889,	38	1903,	129
1890,	23	1904,	125
1891,	53	1905,	105
1892,	56	1906,	130
1893,	51	1907,	125
1894,	53	1908,	134
1895,	52	1909,	128
1896,	65	1910,	139
1897,	59	1911,	176
1898,	75		
1899,	79	Total,	2,155

APPROPRIATIONS.

The appropriations for the year ended Nov. 30, 1911, as recommended by the Board in the annual estimates made under the provisions of chapter 6, section 26, of the Revised Laws, were as follows: —

For the general expenses of the Board,	$32,605 02[1]
For the inspection of food and drugs,	17,500 00
For the production and distribution of antitoxin and vaccine,	20,000 00
For the purity of inland waters,	36,000 00
For the examination of sewer outlets and Neponset River,	14,000 00
For printing the annual report,	5,000 00
State Inspectors of Health,	34,450 00
For the prevention of ophthalmia neonatorum,	2,500 00
Total,	$162,055 02

EXPENDITURES.

The expenditures under the different appropriations for the year ended Nov. 30, 1911, were as follows: —

General Expenditures.

Appropriation (including appropriation for investigation of anterior poliomyelitis, appropriation for typhoid fever, appropriation for slaughtering inspection, and balance of appropriation for Sandy Pond, Merrimack River, etc., brought over from 1910), $32,605.02.

Salaries,	$13,993 10
Traveling expenses,	2,601 10
Stationery, maps and blue prints,	681 13
Printing,	2,625 83
Books, subscriptions and binding,	439 55
Advertising,	64 89
Express charges,	45 93
Extra services,	1,416 09
Messenger,	180 95
Postage and postal orders,	1,317 90
Telephone and telegraph messages,	503 57
Typewriting supplies,	228 25
Special investigations,	607 00
Sundry office supplies,	321 29
Laboratory supplies,	307 80

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[1] In this amount of $32,605.02 is included a balance of $505.02 on the appropriation for Sandy Pond, Merrimack River, etc., brought over from 1910.

Labor and materials,	$60 21
Rent,	25 00
Miscellaneous,	25 65
Total,	$25,445 24

Expenditures for the Production and Distribution of Antitoxin and Vaccine for the Year ended Nov. 30, 1911.

Appropriation,	$20,000 00
Salaries,	$7,985 29
Traveling expenses,	11 26
Express charges,	44 71
Laboratory supplies,	2,373 01
Books and stationery,	52 28
Printing,	251 17
Purchase of animals,	1,516 76
Horse shoeing,	1 25
Food for animals,	3,026 17
Rental of telephone, messages and postage,	105 20
Extra services,	202 84
Water, gas, electric lighting and heating,	411 06
Labor and materials,	223 61
Ice,	94 81
Rent,	2,008 32
Miscellaneous,	246 40
Total,	$18,554 14

Expenditures under the Provisions of the Food and Drug Acts for the Year ended Nov. 30, 1911.

Appropriation,	$17,500 00
Salaries of analysts,	$6,250 00
Salaries of inspectors,	5,398 22
Traveling expenses and purchase of samples,	3,296 91
Apparatus and chemicals,	1,371 61
Printing,	89 63
Services, cleaning laboratory,	104 00
Express and telephone,	13 57
Sundry laboratory supplies,	82 40
Books, binding and stationery,	178 80
Extra services,	13 00
Advertising,	10 50
Miscellaneous,	7 75
Total,	$16,816 39

For carrying out the Provisions of the Act to protect the Purity of Inland Waters, and to require Consultation with the State Board of Health regarding the Establishment of Systems of Water Supply, Drainage and Sewerage.

Appropriation for the year ended Nov. 30, 1911,	$36,000 00

Salaries, including wages of laborers at Lawrence Experiment Station,	$29,199 02
Apparatus and materials,	1,788 16
Rent of Lawrence Experiment Station,	150 00
Repairs and maintenance, Lawrence Experiment Station,	147 48
Traveling expenses,	1,758 45
Express charges,	1,687 84
Books and binding,	210 85
Maps and blue prints,	264 16
Stationery, drawing materials and typewriter supplies,	381 17
Telephone, telegraph messages and postage,	128 15
Extra services and labor,	66 42
Services, collecting samples and reading gauges,	27 00
Miscellaneous,	190 61
Total,	$35,999 31

For the Examination of Sewer Outlets, under the Provisions of Section 4, Chapter 75 of the Revised Laws.

Appropriation for the year ended Nov. 30, 1911,	$14,000 00

Salaries, including wages of laborers at Lawrence Experiment Station,	$9,714 07
Apparatus and materials,	1,557 94
Labor,	75 08
Traveling expenses,	1,877 54
Express charges,	308 25
Telephone and telegraph messages and postage,	51 50
Extra services,	28 31
Services, collecting samples and reading gauges,	89 90
Books, maps, blue prints and binding,	117 07
Stationery, drawing materials and typewriter supplies,	111 03
Miscellaneous,	69 09
Total,	$13,999 78

Expenses under the Provisions of the Act to provide for the Establishment of Health Districts and the Appointment of State Inspectors of Health (Chapter 537, Acts of 1907; Chapters 405 and 543, Acts of 1910; Chapters 603 and 709, Acts of 1911) for the Year ended Nov. 30, 1911.

Appropriation,	$34,450 00

Salaries of State Inspectors of Health,	$25,483 33
Salaries of clerical and other assistants,	2,639 00
Extra services, office work,	36 14
Extra services, State Inspectors of Health,	334 10
Traveling expenses,	3,215 78
Printing,	504 99
Postage,	528 09
Typewriting supplies and purchase of typewriters,	221 85
Books and stationery,	226 35
Laboratory and experimental work,	49 60
Telephone and telegraph messages,	191 45
Office supplies,	117 10
Express charges,	29 82
Miscellaneous,	18 39
Total,	$33,595 99

For carrying out the Provisions of the Act relative to the Board of Approval of Sewerage Works in the Watershed of the Charles River Basin by the City of Boston (Chapter 376 of the Acts of 1908).

Appropriation for the year ended Nov. 30, 1911,	$1,800 00

Salaries,	$1,775 00
Stationery and drawing materials,	9 65
Maps and blue prints,	15 01
Total,	$1,799 66

For carrying out the Provisions of the Act relative to the Supervision of the Business of Plumbing (Chapter 536 of the Acts of 1909).

Appropriation for the year ended Nov. 30, 1911,	$5,100 00

Salary, clerk,	$2,000 00
Wages, second and third examiners,	675 00
Traveling expenses,	513 00
Express charges,	29 56
Printing,	350 33
Postage,	175 14

Books and stationery,	$32 51
Office supplies and purchase of typewriter,	168 28
Plumbers' materials,	39 75
Cleaning,	21 50
Extra services,	875 61
Miscellaneous,	2 60
Total,	$4,883 28

For carrying out the Provisions of the Act relative to the Prevention of Ophthalmia Neonatorum (Chapter 458 of the Acts of 1910).

Appropriation for the year ended Nov. 30, 1911,	$2,500 00

Salaries,	$120 00
Printing,	20 95
Extra services,	16 34
Telephone and telegraph messages,	46 60
Miscellaneous,	1 00
Total,	$204 89

HENRY P. WALCOTT.
CLEMENT F. COOGAN.
JOSEPH A. PLOUFF.
JULIAN A. MEAD.
HIRAM F. MILLS.
ROBERT W. LOVETT.
C. E. McGILLICUDDY.

SUPPLEMENT.

WATER SUPPLY AND SEWERAGE.

ADVICE TO CITIES, TOWNS AND PERSONS.

ADVICE TO CITIES, TOWNS AND PERSONS.

Under the provisions of the Revised Laws (chapter 75, section 117), the State Board of Health is required to

> consult with and advise the authorities of cities and towns and persons having, or about to have, systems of water supply, drainage or sewerage, as to the most appropriate source of water supply, and the best method of assuring its purity or as to the best method of disposing of their drainage or sewage with reference to the existing and future needs of other cities, towns or persons which may be affected thereby. It shall also consult with and advise persons engaged or intending to engage in any manufacturing or other business whose drainage or sewage may tend to pollute any inland water as to the best method of preventing such pollution, and it may conduct experiments to determine the best methods of the purification or disposal of drainage or sewage. No person shall be required to bear the expense of such consultation, advice or experiments. Cities, towns and persons shall submit to said board for its advice their proposed system of water supply or of the disposal of drainage or sewage, and all petitions to the general court for authority to introduce a system of water supply, drainage or sewerage shall be accompanied by a copy of the recommendation and advice of said board thereon.

During the year 1911 the Board has given its advice to the following cities, towns and persons who have applied for such advice under the provisions of this act or under special acts relating to water supply and sewerage.

Official communications were made during the year under the provisions of acts relating to water supply and to sources of ice supply, as follows: —

WATER SUPPLY.

Abington and Rockland.
Acushnet (wells at Long Plain).
Agawam.
Amesbury (Hamilton Woolen Company).
Andover (spring).
Ashburnham.
Ashby (well at Lyman School).
Ashby (Hayward Spring).
Athol (three).
Attleborough (R. Wolfenden & Sons) (two).
Auburn (wells at schools).
Auburn (wells in Pondville) (two).

Barnstable.
Barre (Barre Wool Combing Company).
Belchertown (two).
Beverly.
Beverly (United Shoe Machinery Company).
Beverly (spring).
Blackstone.
Boston (State Hospital).
Braintree.
Bridgewater (Henry Perkins Company).
Chelmsford (well in West Chelmsford).
Cheshire.
Chicopee (Spalding Brothers).
Concord (spring at hospital).
Cummington.
Danvers (spring).
Dartmouth (well in South Dartmouth).
Dighton.
East Bridgewater (well at Beaver School).
Easthampton.
Fairhaven (wells).
Fall River (two).
Falmouth (well at Falmouth Heights).
Foxborough (East Foxborough Water Supply District).
Foxborough (State Hospital) (two).
Framingham.
Georgetown (spring).
Gloucester (well in East Gloucester).
Great Barrington (Housatonic) (two).
Greenfield (Fire District No. 1).
Groton (West Groton Water Supply District).
Hardwick.
Hingham (spring in South Hingham).
Holyoke (spring).
Hudson.
Huntington (Huntington Fire District).
Hyde Park (two).
Hyde Park (spring waters).
Hyde Park (the Stafford Company).
Lakeville.
Lawrence (Pacific Mills).
Littleton.
Lowell (four).
Lynn.
Lynn (Lynn Grease Extracting Company).
Lynn (G. F. Ames & Co. Monumental Works).
Lynn (Hilliard & Merrill).
Lynn (spring).
Malden (Bettinson-Harris Laundry Company).
Mansfield.
Marblehead.
Marshfield (well at Marshfield Hills).
Medford (Joseph Woods & Son Corporation).
Middleborough (two).
Milton.
Milton (spring).
Monson (State Hospital).
Monterey.
Nantucket.
New Bedford (Tuberculosis Sanatorium).
New Bedford (Beacon Manufacturing Company).
Newton (Saco-Pettee Company).
North Attleborough.
North Attleborough (well).
Norton.
Norwood (two).
Norwood (well).
Palmer (town farm).
Peabody.
Peabody (Hunt-Rankin Leather Company).
Peabody (Hill Top Spring).

Peabody (Myles Standish Spring).
Plymouth (Standish Worsted Company).
Plymouth (well at Manomet Bluffs).
Plymouth (Summer's Spring).
Rockland and Abington.
Rowley (well).
Rowley (well at boys' camp).
Salem (two).
Salem (well on Bakers Island).
Sandisfield (spring in Montville).
Shelburne Falls (Fire District).
Southbridge (Glover's Spring).
Southbridge (well).
South Hadley (Fire District No. 2).
Sudbury.
Taunton.
Townsend (two).
Wakefield.
Wareham (Onset) (two).
West Brookfield.
Weston.
Weston (wells).
Westport (well at Y. M. C. A. Camp).
Wilbraham (Collins Manufacturing Company).
Worcester (five).
Worthington.
Wrentham (well at Sheldonville).

ICE SUPPLY.

Hanover.
Manchester.
Pepperell.
Southbridge.
Stoughton.
Winchester.

Official communications were made during the year under general and special acts relating to sewerage and sewage disposal, as follows: —

Fairhaven.
Fall River.
Foxborough (State Hospital).
Framingham.
Gardner.
Hardwick (Gilbertville).
Hudson.
Lancaster (State Industrial School).
Lexington (two).
Marion.
Monson (State Hospital).
Natick.
Palmer.
Palmer (Three Rivers).
Plymouth.
Southbridge.
Springfield.
Stoughton.
Wareham (New Bedford & Agawam Finishing Company).
Weymouth (laundry in South Weymouth).
Woburn (H. W. Clark Leather Company).

MISCELLANEOUS.

Beverly and Salem.
Brockton (Hide-ite Leather Company) (two).
Brockton (Brockton Gas Light Company).
Brockton (Empire Laundry Company).
Canton (Springdale Finishing Company).
Cohasset and Hull.
East Bridgewater.
East Bridgewater (Carver Cotton Gin Company).
Fitchburg (Star Worsted Company).

Hull and Cohasset.
Leicester.
Leicester (Valley Woolen Mill).
Leicester (George W. Olney Woolen Company).
Leicester (Chapel Mills Manufacturing Company).
Lynn.
Mansfield.
Norton (Talbot Wool Scouring Company).
Pittsfield.
Salem and Beverly.
Stoughton.
Stoughton (French & Ward).
Taunton.
Wareham (Onset).
Watertown.
Woburn.
Woburn (Champion Tanning Company).
Worcester.
Worcester (G. E. Duffy Manufacturing Company).
Worcester (Darling Woolen Mills Company).
Worcester (P. F. Pfaffman).

WATER SUPPLY.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to water supply: —

ABINGTON AND ROCKLAND.

JAN. 5, 1911.

To the Committee on Good Water Service of the Commercial Club of Rockland.

GENTLEMEN: — The State Board of Health received from you on Dec. 29, 1910, the following request for information concerning the water supply of the towns of Abington and Rockland: —

> As a committee of the Commercial Club of Rockland, Mass., we would appreciate any information you could give us regarding the safety of the conditions at Big Sandy Pond, in its relation to Little Sandy (Pond) and the outlying cranberry bogs, summer residents, etc., as it may act on the condition of the drinking water which is used in the towns of Rockland and Abington.

An examination of the conditions about your sources of water supply at the present time shows that there are 56 cottages along the shores of Sandy Pond as compared with 37 in 1908 and 20 in 1903. At about 7 of these cottages situated between Big Sandy and Furnace ponds, the sewage disposal arrangements are so placed that drainage from them is probably in the direction of Furnace Pond. There are, however, several other dwelling houses within the immediate watershed of Big Sandy Pond, including the Pembroke Poor Farm. About the shores of Little Sandy Pond, the outlet of which flows to the cranberry bogs and thence to Big Sandy Pond, there are at the present time 35 cottages and a large picnic ground where there were only 8 cottages in 1903. There is in addition a considerable number of permanent dwelling houses on the watershed of Little Sandy Pond, drainage from which finds its way to the pond. A large number of boats is kept on each pond and both are used very extensively for boating and fishing.

In response to a request of the joint board of water commissioners of Abington and Rockland in 1908 for advice as to preserving the quality of the water, the Board advised as follows: —

In accordance with your request of May 29, 1908, for an examination of the conditions about Great Sandy Pond and advice as to the best plan of protecting the purity of the water supply taken therefrom, the State Board of Health has caused the pond and its tributaries to be examined by its engineer.

The results of this examination show that the number of cottages about Great and Little Sandy ponds has nearly doubled in the last five years and that there has been a great increase in the number of persons who resort to these ponds during the summer season.

In response to an application for advice as to protecting the purity of the water of this source in 1903 the Board stated that on account of the use of the ponds as a summer resort there would be great and increasing difficulty in preventing the pollution of their waters, unless the control of the lands about them should be acquired by the towns.

It was evident that the cost of acquiring the necessary property even at that time would be large, and in view of the circumstances the Board recommended an investigation to determine the practicability of obtaining an adequate supply of water for the towns from wells or other suitable works in the neighborhood of Great Sandy Pond. This advice has not been carried out, and in the meantime the conditions affecting unfavorably the purity of the water of the ponds have grown much worse.

It is impracticable, in the opinion of the Board, to protect adequately the purity of the water of Great Sandy Pond unless much of the property about it and about Little Sandy Pond shall be acquired by the towns and the further use of these ponds as a summer resort prevented. The cost of acquiring the lands, buildings and other property necessary to protect this water supply adequately would now be so great that there is very little doubt in the opinion of the Board that it would be much less expensive to discontinue the further use of water taken directly from the pond and secure water, if practicable, from the ground near the pond by means of wells or other suitable works as advised by the Board in its communication of April 2, 1903.

While an unsuccessful attempt was made when the works for taking water from Great Sandy Pond was first built to obtain water from a filter gallery near the present pumping station, it does not appear that any further investigation as to the practicability of obtaining a ground water supply in this region has ever been made, and the Board again recommends that you make a thorough examination of the region about the pond to determine definitely the practicability of obtaining there a ground water supply suitable for the requirements of the towns. If a ground water supply can be obtained at no great distance from your present pumping station, the cost of works and of the necessary land for adequately protecting the purity of the supply will not be great. It is important, however, that there be no unnecessary delay in carrying out this work, since the number of buildings about the pond is increasing rapidly and favorable localities for obtaining ground water are likely soon to be occupied.

In carrying out this work it is very important that you secure the assistance of an engineer of experience in the investigation of ground water supplies, and if you decide to make the investigation advised the Board will, upon application, give you such assistance as it can by making the necessary analyses of water and will give you further advice when the results of the investigation are available.

Investigations as to an additional water supply as recommended in the communication of the Board were begun but were discontinued after sinking a few wells before the probable quantity and quality of the water to be obtained in this way had been determined. There is no doubt that under the present conditions there is serious danger that the water supply of the town may at any time be polluted in such a way as to cause sickness, and in the opinion of the Board it would be for the best interests of the towns concerned to take the necessary action to provide a safe public water supply.

AGAWAM.

JULY 6, 1911.

To Messrs. JAMES F. BARRY, JAMES H. CLARK and ALBERT K. FULLER, *Committee on Water Supply.*

GENTLEMEN: — In response to your request for advice as to the use of water for the supply of Agawam from a deep tubular well at Feeding Hills temporarily or until such time as water can be obtained from the city of Springfield or elsewhere, the State Board of Health has caused the well and its surroundings to be examined by one of its engineers, and samples of the water to be analyzed.

The source from which it is proposed to take water for the supply of the town is a tubular well located on the premises of E. A. Kellogg, about half a mile north of the village of Feeding Hills. The Board is informed that this well is 6 inches in diameter and 245 feet in depth, the lower 200 feet being in rock. It also appears that the well has been in use as a source of water supply for many years, water being used at the present time for the supply of six or seven dwelling houses, a schoolhouse, library and the town hall. Very little information is available as to the yield of the well, though it is said that water has been pumped from it for several hours at a rate of a little over 40,000 gallons per day. It is understood that in case the quantity supplied by the well is insufficient for the supply of the town, another deep tubular well will be sunk somewhere in its neighborhood.

The results of several analyses of samples of water from the well now in use show that it is excessively hard and contains a much larger quantity of iron than is found in good ground waters. The water is also turbid, with some color, and the results as a whole indicate that if this water should be introduced for the supply of the town, it would be objectionable for most domestic purposes on account of its excessive hardness and the large quantity of iron which it contains. Experience has shown that waters of this character almost invariably deteriorate greatly with continued use, and it is probable that this water would deteriorate materially if the quantity of water required for the supply of Agawam should be drawn continuously from this well.

Moreover, no sufficient test as to the yield of the well has been made to show whether it would furnish enough water for the requirements of the town, and the indications furnished from such information as is now available are not favorable for obtaining continuously from this source enough water for the present needs of the inhabitants of Agawam.

It might be possible, as suggested, to increase the yield of the source by putting in another well near the one now in use, but it is very doubtful whether a material increase in the supply could be made in this way, and such a well would cost a considerable sum of money.

The works of the city of Springfield for taking water from Little River are now completed, and there appears to be no good reason why that city cannot supply water to the town of Agawam in the very near future, after the Little River system has been in use long enough to bring it into good working order and make certain its continuous operation; and it is also possible that an adequate supply of excellent water will be obtainable from the town of West Springfield before very long, since preparations are now being made for the introduction of a more abundant supply in that town.

It is also possible that the town of Agawam can obtain a supply of water of good quality within its own limits, though the necessary investigations to determine this question have not yet been undertaken.

The arrangement of the pipe system of the town will depend to a considerable extent upon the source from which the permanent future supply is likely to be taken, and it seems to the Board very important, in the interest of economy in constructing the works and especially of efficiency in their operation, to select definitely the source of supply in the beginning.

Considering the circumstances, the Board cannot recommend the construction of works for taking water from the wells in Feeding Hills, as proposed in your application, and the Board recommends that a further effort be made to secure arrangements by which the town may be supplied in the near future from the city of Springfield or the town of West Springfield, failing in which the Board recommends that you make tests in more favorable locations in Agawam for the purpose of obtaining a ground-water supply of suitable quality for all requirements.

If a suitable supply of ground water can be found within the limits of the town, it is likely that the cost of introducing water from such a source, even including the cost of the necessary tests and investigations, would be considerably less than the cost of taking a supply temporarily from the proposed wells at Feeding Hills and subsequently in the near future abandoning that source when a more favorable one becomes available.

ASHBURNHAM.

SEPT. 7, 1911.

To the Ashburnham Citizens' Association, Ashburnham, Mass., MR. A. H. SKILLINGS, *Secretary.*

GENTLEMEN: — The State Board of Health received from you on Aug. 26, 1911, an application for advice as to an additional water supply for Ashburnham, to be taken from the ground near Naukeag Pond, and has caused an examination to be made of a test well recently put in near the pond and a sample of the water from this well to be analyzed.

The results of the analysis indicate that water from the ground in this locality would be of good quality for domestic purposes. Regarding the quantity of water obtainable from the ground at this place by means of a well or other works, it is impracticable to advise you definitely without further investigation. The soil about the well apparently consists largely of porous gravel, and porous soil was encountered in sinking the test well. In view of the conditions, the Board recommends that you make a further test by sinking a well or tubular wells to a depth of at least four feet below the level of the water in the pond, and by pumping from the well or wells for a period of several days at a rate as great as will be necessary to furnish the quantity of water required for Ashburnham. The Board will assist you in these investigations by making the necessary analyses of water and will give you further advice when the results of the further tests suggested are available.

ATHOL.

JAN. 5, 1911.

To the Board of Water Commissioners of the Town of Athol.

GENTLEMEN: — The State Board of Health received from you on Dec. 17, 1910, the following application for advice as to a proposed additional water supply for the town of Athol: —

> It is proposed that the town of Athol acquire additional storage for its water supply and a reservoir site has been chosen on the Thousand Acre Meadow Brook.
>
> The enclosed blue print shows the Thousand Acre Meadow Brook and watershed. It is proposed to erect a dam on this brook at a point between where it crosses the Cobb Road and where it crosses the South Royalston Road on its way to Millers River. A 40-foot dam here would flow perhaps 150 acres, with a watershed of over 2 square miles.
>
> Habitations on this watershed are shown by dots and numbers, viz.: Nos. 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16.
>
> As you are aware, the Phillipston Reservoir of the water department is at the head of the Thousand Acre Meadow Brook.
>
> This plan is respectfully submitted for your consideration and an early report would be appreciated, as conditions make it necessary for us to act at once for the economical purchase of this land.

It does not appear that surveys or investigations to determine definitely the location of the proposed reservoir or to furnish information as to the probable cost of the works, have yet been made. The location of the proposed dam, as indicated to the Board, would be about 700 feet northwest of the Cobb Road, so called, and judging from the State map, the proposed reservoir with a dam of 40 feet or thereabout in height might have a capacity of 600,000,000 gallons and a drainage area of a little over two square miles.

The Board has caused the locality to be examined by one of its engineers and a sample of the water, collected from the stream flowing through the meadow and sent in by your department, to be analyzed. The watershed contains very few dwelling houses and only a few of these are so situated as to be likely to affect materially the quality of the water. By purchasing the buildings from which pollution is most likely to find its way into the streams, the watershed of the proposed reservoir would be practically free from serious danger of sewage pollution.

At the time of the examination it was impracticable to obtain a sample of water from the stream flowing through the meadow, but a sample sent in by you subsequently, collected from the first considerable quantity of water flowing after the recent severe drouth, had a high color and contained a very large quantity of organic matter, its condition evidently being due to contact with vegetable matter in swamps. This sample may not give a fair indication of the quality of the water of this source, but it is evident that there is a large area of swamp at the location of the proposed reservoir, and the indications are that the water is likely to be affected by high color and an excessive quantity of organic matter.

Judging from the information thus far available, the cost of securing water of reasonably satisfactory quality from this source by the proposed plan would be large. It is possible, however, that a more favorable site for a reservoir may be found elsewhere on the stream and that water of better quality may be obtained at another location at less cost than at the one suggested in the plan presented.

Considering the circumstances, it is impracticable for the Board to advise you definitely, with the information now available, whether or not the proposed source would be an appropriate or desirable one for the town to adopt, and the Board recommends that before deciding upon this source of supply you cause an investigation to be made with the assistance of an engineer of experience in such matters, to determine the practicability and probable cost of constructing a suitable reservoir at the location indicated or at any other available location in this valley, and that in this investigation be included a careful consideration of the means necessary to provide water of satisfactory quality from the proposed new source. If it is found practicable to build a reservoir of the size indicated at or in the neighborhood of the place indicated upon the plan presented, it will probably be desirable to discontinue the use of the Phillipston Reservoir, which is affected in nearly every year by excessive growths of the organism *Anabæna,* and to draw off the water so as to prevent injury to the quality of the water of the proposed new reservoir on the stream below.

The Board recommends also that in your further investigations you consider other possible sources of supply, of which there appear to be several in the immediate neighborhood of Athol, among which may be found a source which will furnish water of better quality and at less cost than by the plan now proposed. When the results of further investigations are available, the Board will, if you so request, give you further advice as to increasing and improving the water supply of the town.

You have also requested verbally advice as to the practicability of obtaining a large additional supply of water from the deep tubular well now being sunk in the valley below Phillipston Reservoir. From the information presented to the Board, it appears that this well has now been sunk to a depth of about 475 feet, mostly through rock, and that its yield amounts to slightly more than 20,000 gallons per day. Judging from experience with numerous wells in similar locations in various parts of the State, it is improbable that an adequate supply of good water can be obtained by sinking the well now under construction to a greater depth or by sinking wells in rock here or elsewhere in this region. An analysis of a sample of water collected from this well on December 28 shows that, while the water is low in organic matter, it is excessively hard and would be an undesirable source from which to take water for domestic purposes.

JAN. 5, 1911.

To the Board of Water Commissioners of the Town of Athol, Mass.

GENTLEMEN: — The State Board of Health has considered your application for approval of the taking of water from Lake Ellis, so called, for the supply of the town of Athol in case of emergency, and has caused the lake and its surroundings to be examined and a sample of the water to be analyzed.

The results of the examination show that the watershed of the lake contains many dwelling houses with outbuildings, most of which are situated along the shores of the lake or near the brook which feeds it, and from some of which polluting matters may find their way into the lake at times of thaw or rain. The analysis of the water of the lake shows a considerable deterioration in its quality as compared with an analysis made at the time when it was proposed to use this lake as an emergency water supply for the town two years ago.

As a result of the examinations, the Board is of the opinion that this lake cannot be regarded as a safe source of domestic water supply, and in case it becomes necessary to use water from this source for the supply of the town all of the water used for drinking should be boiled.

JULY 19, 1911.

To the Board of Water Commissioners of the Town of Athol.

GENTLEMEN: — The State Board of Health received from you on June 26, 1911, an application for advice as to a proposed additional water supply, to be taken from Thousand Acre Meadow Brook, the water of which it is proposed to divert at a point about 2,000 feet north of the South Royalston Road, and convey by a pipe line to the existing pipe line leading from the Newton Reservoir to the Summer Street and Low Level reservoirs, and thus supply the water to the town. The additional area of watershed that will thus be made available for the water supply of Athol will be 2.59 square miles exclusive of Phillipston Reservoir at the upper end of this stream, which has a watershed of 0.66 of a square mile.

It appears from the investigations that have thus far been made that it is practicable, by constructing a dam on this brook at the South Royalston Road, and a dike near this road farther east, to form a reservoir having a capacity of 1,300,000,000 gallons with a dam 18 feet in height, and it is evident that the entire flow of this watershed in periods of dry years can be made available for the water supply of Athol.

Your plans for the development of this area are outlined as follows: —

> Because of the large area covered by the reservoir it would, from a financial standpoint, for a town the size of Athol, be out of the question to strip it. For this reason our plans of development are, to lay the pipe line not from this large reservoir but from a small intake constructed at a point about 2,000 feet farther down the stream and the construction of a filtration bed in between. As the water is discharged from the larger reservoir it can first be passed through a fountain located at a short distance below the toe of the dam, then pass down the bed of the brook where it will aerate itself before it passes through the filter beds on its way to the intake reservoir. By this treatment any odor or taste produced by organisms in the larger reservoir ought to be eliminated.
>
> Should, however, one filtration not be sufficient to do this, double filtration, as the plans show, can be accomplished, since the fall in the brook between the base of the dam of the larger reservoir and the surface of the water in the intake would be 25 feet.

You have also submitted two plans showing the possible development of this source, — one, Plan A, a development for present needs, which provides for the construction of a small diversion reservoir, two open sand filters and an intake reservoir, through which the water will be delivered to the pipe line leading to the town; and two, Plan B, showing a larger diversion reservoir and a group of preliminary filters and subsequently a receiving reservoir and group of secondary filters, from which the water will be discharged to the intake reservoir.

It appears to be practicable to carry out this plan in parts as proposed, and for the present to construct only the works provided for in Plan A, since by this plan it is estimated that the capacity of the present water works can be increased by about 600,000 gallons per day, — a quantity which is estimated to be about equivalent to the present consumption of water by the town.

The Board has carefully considered the plans and information submitted and the results of analyses of the water of Thousand Acre Meadow Brook, and concludes that the plan of enlarging the water supply of Athol by taking water from that source and supplying it to the town after filtration through intermittent sand filters is an appropriate method of enlarging the water supply of the town. The population on the watershed of Thousand Acre Meadow Brook is very small, and by the purchase of dwelling houses, as proposed, it will be practicable to protect adequately the purity of this stream as a source of water supply. The filters proposed in Plan A are of adequate size for the present requirements, and by their use the water can be greatly improved and the color materially reduced, so that the quality of this water may be made much better than that of the present sources. Whenever it becomes necessary in the future to enlarge the supply, the works can be developed as suggested in Plan B and a large additional supply obtained, which will meet the requirements of the town for a very long time in the future.

The Board, acting under the provisions of chapter 257 of the Acts of the year 1905, consents to and advises the adoption of the plan presented known as Plan A, which provides for taking the water of Thousand Acre Meadow Brook at the South Royalston Road, filtering it intermittently through sand filters having an area of 0.55 of an acre, composed of 4.5 feet in depth of sand suitable for the purpose, the water subsequently to be delivered through an intake reservoir to pipes leading to the town. It will be desirable to so arrange the pipes that water from the filters can be delivered directly into the pipe lines leading to the town in case it is found necessary to clean or repair the reservoir or for any other reason desirable to deliver the water directly to the distributing system.

The success of the plan will depend very largely upon the care used in the design and construction of the works, and the Board recommends that they be carried out under competent engineering supervision.

BARNSTABLE.

JULY 6, 1911.

To the Barnstable Water Company, Barnstable, Mass.

GENTLEMEN: — The State Board of Health has considered your application for the consent of the Board to the taking of water for domestic purposes from the ground on the westerly side of Mary Dunn Road, near Upper Gate Pond in the easterly part of the town of Barnstable, and has caused the locality to be examined by its engineer and samples of water from test wells in this locality to be analyzed.

It appears that 24 wells have thus far been driven in this locality, their depths ranging from 25 to 35 feet, and that 6 of these wells were connected together and a pumping test made by pumping from these wells at a rate of about 250,000 gallons per day from June 20 to 23, inclusive. The results of analyses of samples of water collected during this test show that the water is of excellent quality for the purposes of a public water supply.

The soil about the wells is favorable for the absorption of a large portion of the rainfall, and the test wells penetrated a stratum of coarse sand, from which water could be drawn very freely. Considering the location and the results of the pumping test, it is probable that an ample quantity of water for all requirements of Barnstable can be obtained from the ground in the region in which the wells are located.

The Board, acting under the provisions of chapter 286 of the Acts of the year 1911, consents to the taking of water from the ground on the westerly side of Mary Dunn Road near Upper Gate Pond, and approves the location of the wells from which the supply is to be drawn, as shown upon the plan filed with your application.

BELCHERTOWN.

JULY 6, 1911.

To Mr. AMASA M. BAGGS, *representing Proposed Incorporators of the Belchertown Water Company, Belchertown, Mass.*

DEAR SIR: — The State Board of Health has considered your communication of June 15, 1911, relative to supplying water to the main portion of the village of Belchertown from certain springs in the low ground west of the village, and has caused the locality to be examined by one of its engineers and samples of the water from the sources indicated to be analyzed.

The springs examined are located in low ground on the westerly side of the road leading from Maple to Walnut Street, about 1,750 feet west of Main Street. Test wells have been dug at each of the springs and a sample of water collected from each of these has been analyzed. The results show that the waters of all of the wells have at some time been considerably polluted, though subsequently quite well purified in their passage through the ground before entering the wells. The source of this pollution is probably the population upon the hillside above the wells, and in view of the conditions found by this examination it is unlikely, in the opinion of the Board, that an adequate supply of good water can be obtained from the springs indicated or from the ground elsewhere in this locality.

The conditions for obtaining water freely from the ground are very favorable at several points in the neighborhood of the town, especially in the valley of Jabish Brook, where it is very probable that an ample supply of water of good quality can be obtained at some point very close to the village, yet so located that it is unlikely to be affected by drainage therefrom or by other pollution.

The Board recommends that tests be made with a view to obtaining water from the ground in the valley of Jabish Brook, north or east of the village, where the conditions appear to be most favorable for obtaining a supply of water from the ground by means of wells or other suitable works. The Board will assist you in these investigations by making the necessary analyses of water and will give you further advice when you have the results of further investigations to present.

DEC. 7, 1911.

To Mr. A. M. BAGGS, *Belchertown, Mass.*

DEAR SIR: — In response to your request for an examination of the water of certain test wells in the valley of Jabish Brook northeast of the village of Belchertown, and advice as to the use of water from that locality for the supply of the village, the Board has caused the wells and their surroundings to be examined by one of its engineers, and samples of their waters to be analyzed.

The water of test well No. 1, located about 150 feet southwest of the brook and 250 feet southeast of the highway leading from Belchertown to Enfield, was found to be affected somewhat by pollution, probably derived from the buildings and heavily fertilized lands in the neighborhood of the well. The water of well No. 2, located about 600 feet farther down the valley of the brook, southeast of well No. 1, was found to be of very much better quality.

It appears from the information furnished the Board that both wells penetrated porous soil, from which water could be drawn very freely. In view of the results thus far obtained, the indications appear to be favorable for obtaining a water of good quality and in considerable quantity from the ground in the valley of Jabish Brook between well No. 2 and the millpond below it.

The Board recommends as the next step in your investigations that you sink additional wells between well No. 2 and the millpond below it, and that you connect several of these wells together and pump from them for a period of several days at a rate as great as would be necessary for the requirements of the district which it is proposed to supply. The Board will assist you in the further investigations, if you so request, by making the necessary analyses of water and will give you further advice when you have the results of further tests to present.

BEVERLY.

OCT. 5, 1911.

To the Board of Water Commissioners, Beverly, Mass.

GENTLEMEN: — In response to your request for an examination of the water supplied to Beverly from Wenham Lake, and advice as to the cause of the objectionable odor complained of by water takers at the present time, the Board has caused the lake to be examined and samples of the water to be analyzed.

The results of the examination show that the water of the lake contains at the present time large numbers of the organism *Anabæna,* which is a common cause of objectionable tastes and odors in the waters of ponds and reservoirs at this season of the year. While the presence of this organism in large numbers makes the water very objectionable, the use of the water under these conditions is not known to be injurious to health. The organism flourishes usually in the late summer and early fall, chiefly in the months of August and September, and it is likely to disappear from the water of the lake within a short time. Experience at other places indicates that less complaint is likely to occur if the flushing of the pipes is omitted until the organism has disappeared from the waters of the lake.

BLACKSTONE.

JUNE 28, 1911.

To the Water Supply Committee of the Town of Blackstone, Messrs. JOHN F. MEANEY, ANDREW N. MAXON and OLNEY A. PICKERING.

GENTLEMEN: — The State Board of Health received from you on June 16, 1911, the following application relative to a proposed water supply for the town of Blackstone: —

> In behalf of Andrew N. Maxon, Olney A. Pickering and John F. Meaney, water supply committee for the town of Blackstone, appointed under authority of a vote, a copy of which has been filed with your Honorable Board, I would ask the opinion of your Board upon the sources of water supply and quality of the water to be furnished by the city of Woonsocket, R. I., under authority of chapter 604 of the Acts of 1910.

The application is accompanied by copies of votes of the town of March 20, 1909, and Sept. 24, 1910, which were respectively as follows: —

> *Voted,* That a committee of three be appointed by the Moderator to confer with the water commission of Woonsocket, R. I., with the view of securing legislation to allow the furnishing of water for domestic or other purposes to the inhabitants of the town.
>
> *Voted,* That Andrew N. Maxon, Olney A. Pickering and John F. Meaney, water supply committee, and the board of selectmen acting jointly, are hereby authorized and empowered to contract with the city of Woonsocket or its legal representatives for the installation and maintenance of hydrants for protection against fire, not to exceed ten in number, upon public highways in Precinct 1, at a cost not exceeding $30 per hydrant per year, and for a term not exceeding ten years. Said hydrants shall be located at points upon said highways to be fixed upon by said joint committee.

The Board has also received the following communication from the Woonsocket Water Department, under date of May 9, 1911: —

> Negotiations are in progress between this department and officials of the town of Blackstone, Mass., for the extension of our water system into that town to furnish fire and domestic water service. Legislation for the extension petitioned for was passed last June, chapter 604 of Acts of 1910.
>
> Section 2 of this act concludes as follows:
>
> *Provided further*, that no source of water supply for domestic purposes shall be acquired or used under this act without the consent and approval of the state board of health.
>
> It seems advisable before negotiations proceed further that it be ascertained if the Massachusetts Board will sanction our water supply. I will be glad to co-operate with you in this matter, and if you will advise me as soon as convenient what you require of this Department I will be greatly obliged.

The Board has caused the sources of water supply of the city of Woonsocket to be examined by one of its engineers and samples of the water to be analyzed, and has considered the information that has been furnished as to the conditions affecting this water supply. The results of the examination show that the water is highly colored and contains much organic matter, due probably to contact with vegetable matter in swamps on the watershed and in the bottoms of the reservoirs from which the supply is drawn. It appears that the water is also at times affected by a noticeable taste and odor, due probably to microscopic growths. The watersheds of the reservoirs, however, contain but little population, and these sources are not at the present time exposed to serious danger of pollution by sewage, which might affect their safety for drinking. It is also probable that the quantity of water which these sources will yield will be sufficient for the supply of Blackstone in addition to Woonsocket, even in dry seasons, for several years in the future.

It is probable that an ample supply of ground water of good quality can be obtained for the supply of the town of Blackstone within its own limits, and the cost of a supply obtained in this way might be no greater on the whole than the cost of a water supply from Woonsocket. Moreover, such a water supply would be far more satisfactory in quality than water from any surface source, and the Board believes it would be for the best interests of the town to secure a supply of ground water from some point within its own limits for its permanent use.

Under present conditions it is important that a domestic water supply shall be provided for Blackstone village as soon as practicable, and since a supply can be secured without delay from the Woonsocket water works, the Board consents to and approves the taking of water from that source.

BOSTON (STATE HOSPITAL).

JUNE 12, 1911.

To the Boston State Hospital, HENRY P. FROST, M.D., *Superintendent, Dorchester Center, Mass.*

GENTLEMEN: — In accordance with your request of May 11, 1911, for an examination of the water of a well at the Psychopathic Hospital now under construction on Fenwood Road near Vila Street, and advice as to its suitability for drinking, cooking, washing and use in boilers, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The results show that the water is excessively hard and contains a greater quantity of organic matter than is found in good well waters. It is not suitable for use for drinking or cooking and would probably be objectionable for use in boilers. The quantity of iron in the water at the present time is not excessive, and it may be unobjectionable for use in cooling and for washing and flushing. It is possible, however, that the quantity of iron will increase with use and if so, the water would be likely to stain bowls and other surfaces with which it comes continually in contact. A considerable change might occur in the quality of this water after a large quantity had been drawn continuously from the well, and if you conclude to test the quality further by pumping from the well or using it continuously for a time, the Board will, upon request, make a further analysis and give you further advice as to the quality of the water.

BRAINTREE.

JULY 19, 1911.

To the Committee on Water Supply of the Town of Braintree.

GENTLEMEN: — The State Board of Health received from you on June 19, 1911, a communication stating that your committee is considering certain plans relative to the water supply of the town of Braintree, concerning which you request the advice of the Board. The plans are the following: —

No. 1. The continued use of the present systems; *i.e.,* filter gallery and tubular wells at Little Pond and the waters of Great Pond.

No. 2. A system of tubular or of artesian wells to help out the above systems.

No. 3. Raising the water level of Great Pond and using that supply alone, or in connection with the existing systems.

No. 4. Carrying the waters of Great Pond to Little Pond by a gravity conduit, and using the waters of the two ponds and possibly that of Farm River, — the entire pumping being done at Little Pond.

No. 5. Joining the metropolitan water system.

You also refer to the advice of the Board relative to the water supply of the town, dated May 7, 1903, and the report of the town's engineer at that time, filed in this office, as the data on which your committee has begun its investigations. You have also obtained from the Metropolitan Water Board an estimate of the cost of entering the Metropolitan Water District and the cost of obtaining a supply from that source.

The Board has caused your present sources of supply to be examined by one of its engineers, and has considered the information available and the results of chemical analyses of the water of your present sources of supply since the previous examination in 1903.

It appears that at the present time your water supply is taken from the filter gallery and wells near Little Pond, supplemented with water drawn from Great Pond. Calculations of the probable yield of Little Pond, including the filter gallery and wells in its neighborhood, indicate that it is probably capable of yielding about 400,000 gallons per day in a series of very dry years, but its yield would be reduced if sewers should be built to serve the populated portions of this watershed.

Great Pond is used jointly by Randolph, Holbrook and Braintree, and the three towns apparently have rights to equal shares of its waters. Its yield in a series of very dry years probably does not much exceed 2,100,000 gallons per day, and the quantity available for Braintree, when Randolph and Holbrook are using the amounts to which they are entitled, would be about 700,000 gallons per day. In this case also the yield would probably be reduced if sewers should be constructed to remove sewage from the populated portions of the watershed.

Used together, the capacity of your present sources is probably about 1,100,000 gallons per day, though a greater quantity will be available until Randolph and Holbrook use their full rights to the waters of Great Pond.

The quantity of water used by the town in the year 1910, according to the pumping records, amounted to an average of 653,000 gallons per day or 81 gallons per inhabitant. There have been some very remarkable fluctuations in the quantity of water used in Braintree within the past few years, the quantity used in 1908, for example, apparently amounting to only 424,000 gallons per day and the quantity used in 1909 to

493,000 gallons per day. The cause of the marked increase in the use of water in 1910 has not been investigated, though evidently a very large quantity of water is used from the public supply for mechanical and manufacturing purposes. The town is growing rapidly, and on account of its nearness to Boston is likely to continue to increase rapidly in population in the future; and in view of the fact that the town as yet has no sewers, it is likely that when a system of sewerage is provided, the quantity of water used will exceed the amount now required. Nevertheless it is likely that the present sources of supply will be adequate for the requirements of the town for the next ten years at least and possibly for a considerably longer time.

The population on the watershed of Little Pond has increased considerably in recent years, and now amounts to about 650 persons, or over 1,200 per square mile, and as no sewers have been constructed, all of the sewage and drainage from this population is disposed of within the watershed. Analyses of the water of Little Pond show a considerable deterioration in its quality since the examinations in the years 1902 and 1903 on which the previous advice of the Board was based. There is no reason to expect improvement in the future, but on the contrary continued deterioration until sewers have been provided for the removal of sewage from the watershed, especially from the neighborhood of the filter gallery and wells.

The watershed of Great Pond contained when examined in 1902 a population of about 580, or about 170 persons per square mile. A recent examination indicates that this population has now increased to as much as 1,500, or over 430 to the square mile. In this case also no sewers have been provided for removing the pollution from the tributaries of this water supply, and all sewage is disposed of within the watershed. The analyses of the water give marked evidence of the increase in population on the Great Pond watershed.

It appears to the Board essential that, if the use of the present sources of supply of the town of Braintree is to be continued, some provision be made in the near future either for the removal of sewage from the watersheds of the sources of supply or for the purification of the water efficiently by filtration, so as to prevent danger of injury to health from its continued use.

As to other possible methods of obtaining a water supply you mention the use of Farm River, — known, also, as Blue Hill River, — taking the water at the point at which the stream would be crossed by the proposed conduit between Great and Little ponds, the possibility of securing water from the ground by means of tubular wells, and the taking of a supply of water from the Metropolitan Water District.

The watershed of Farm River includes a very large part of the Blue Hill Reservation of the metropolitan parks district, which is set apart to be kept for the free use of the public. This reservation is already a resort of great numbers of people during a large part of the year, and these areas are likely to be visited by increasing numbers in the future. Under the circumstances it is not advisable, in the opinion of the Board, for the town of Braintree to use Farm River as a source of public water supply unless the whole supply be filtered. If the plan of filtering the entire supply should be adopted the use of Farm River would increase very materially the quantity of water available for the supply of the town.

Regarding the possibility of obtaining a ground-water supply, it appears that practically all of the yield of the Little Pond watershed is now obtained from the ground through the filter gallery and the tubular wells in its neighborhood, and no material increase in the yield of the Little Pond watershed could be effected by additional wells within its limits. In some places in the neighborhood of Great Pond the conditions appear to be favorable, so far as can be judged from surface indications, for obtaining water freely from the ground, and it is possible that the town could take the water to which it is entitled from Great Pond by means of wells, filter galleries or other suitable works rather than direct from the pond. While no enlargement of the quantity of water available for the town could be obtained in that way, a water of much more satisfactory quality would be secured if the water should be taken from the ground instead of directly from the pond. Further tests would be necessary, however, to determine the practicability of securing an adequate water supply by such a plan.

Very little information is available as to the practicability of obtaining a ground-water supply adequate for the requirements of Braintree at other points within the limits of the town. There are areas in the southeasterly part of the town which appear to be composed of porous soil, but owing to the presence of population or for other reasons it does not seem desirable to attempt to take water from the ground in that region. In the southerly part of the town and in adjacent parts of Randolph there is a large area in the valley of the Monatiquot River, in which a supply of ground water might be obtained, though the conditions do not appear to be as favorable, so far as can be judged from surface indications, as they are in the district farther to the east.

The only way in which the practicability of obtaining a ground-water supply can be definitely determined will be by making tests by means of tubular wells in the more favorable localities and obtaining the necessary information as to the character of the soil and quality of the water obtainable in these districts.

There is no doubt that an adequate supply of excellent water can be obtained by the town from the Metropolitan Water District. The cost of such a supply can be determined very closely, and your committee is already informed as to the probable cost of a supply from that source.

From the information at hand it appears to the Board that it is practicable to obtain an adequate quantity of water from your present sources of supply to last the town for several years in the future, — probably at least ten years and perhaps for a considerably longer time. It is possible to protect the supply from Great Pond adequately, for some time in the future at least, by providing sewers to remove the sewage from the more thickly settled areas and maintaining thorough inspection. It is not probable, however, that the use of the present filter gallery and wells near Little Pond can be continued with safety in the present location. Possibly by putting in sewers to remove the sewage from the populated areas in this watershed, moving the filter gallery and wells to the opposite side of the pond away from dwellings and their sewers, and keeping the pond nearly full at all times, a good water could be obtained and the quality of the water of the sources restored to the best conditions that have obtained in the past. Information is lacking to show whether the conditions are such that it would be practicable to locate the filter gallery at the opposite side of the pond in soil favorable to its successful operation.

Water of very good quality could be obtained by filtering efficiently the water of the present sources, supplemented if desired with water taken from Farm River, or by joining the Metropolitan Water District, and a good ground-water supply would be better than any of the others, especially on account of its low temperature in summer, if such a supply could be obtained.

Conclusions as to the more desirable course for the town of Braintree to follow under the circumstances will depend very largely upon the cost of the various plans. The estimates should include a careful examination of the condition of your present works, especially the pumping machinery, buildings and appurtenances, and the cost of enlarging and maintaining them to meet the needs of the town until the use of water shall equal the capacity of the present works. If it is decided to investigate the feasibility of obtaining a ground-water supply, tests should be made in the more favorable localities sufficient to determine the practicability and probable cost of supplying the town by this method, and the Board would add that the present is an exceptionally favorable time for such work.

Considering the circumstances, the Board recommends that you have estimates of the cost of the various plans which were made several years ago revised and brought up to date by your engineer, so that a direct comparison may be made with the present estimated cost of obtaining a supply from the Metropolitan system. If your committee desires to determine the question of the advisability of obtaining a ground-water supply for the use of the town, the necessary tests should be begun as soon as practicable in order to take advantage of the present favorable conditions. When the results of these estimates and investigations are available, it will be practicable to determine more definitely whether it will be for the best interests of the town to continue to use the present sources of supply, or to secure a supply wholly or in part from the ground, or to discontinue the use of the present sources and take water from the Metropolitan Water District; and if you will submit the results of the estimates and investigations the Board will advise you as to the most appropriate plan for the town to adopt.

CHESHIRE.

JULY 6, 1911.

To the Cheshire Water Company, Cheshire, Mass.

GENTLEMEN: — Attention has been called to the conditions affecting the purity of the water of Thunder Brook, from which the supply of Cheshire is taken in part, and the Board has recently caused the source to be examined by one of its engineers and by the State Inspector of Health of this district.

The results of the examination show that the watershed contains about eleven dwelling houses, most of which are so located that their drainage probably has little unfavorable effect upon the quality of the water. One of the houses, however, is located within about 150 feet of one of the feeders of the brook, on land which slopes very abruptly from the house to the stream, so that at times of rain and when the ground is frozen, waste matters from the dwelling and outhouses apparently find their way to the brook. At another group of buildings the sink drainage finds its way into the small stream flowing from a spring and is carried to one of the feeders of the reservoir. Drainage from a third house also apparently reaches at times to the road along the northerly bank of the brook and may thence be carried into the brook at times of rain. There is also considerable travel over the road which passes near the brook above the reservoir, wash from which enters the reservoir freely.

Under these conditions the brook cannot be regarded as a safe source from which to take water for domestic purposes, and the Board recommends that the use of the source be discontinued until measures shall be taken which will prevent danger of pollution of the water from the buildings on the watershed.

CHICOPEE (SPALDING BROS.).

MARCH 2, 1911.

To the Board of Health of the City of Chicopee.

GENTLEMEN: — In response to your request for an examination of the water used at the Spalding Bros.' factory in Chicopee and advice as to its quality, the State Board of Health has caused the sources of supply used at the factory to be examined and samples of the water to be analyzed.

It appears from the information presented to the Board that the factory is supplied chiefly from a tubular well about 207 feet in depth, located near the easterly end of the factory, between the canal and the Chicopee River, and that a small quantity of water is occasionally drawn from the public water system of the city of Chicopee. It appears further that the water drawn from the well is pumped to a storage tank on the roof of the main building and from thence is supplied to the factory and used both for drinking and in the manufacturing processes. After being used in manufacturing a part of the water is discharged into a small tank, whence it flows through a drain to the river, while the remainder is returned to another tank and thence pumped back with the well water to the supply tank on the roof of the building.

A sample of water taken from the tubular well does not show any marked traces of pollution, though containing a slightly greater quantity of organic matter than is found in good well waters, but the water is very hard, and this well is not a desirable source of drinking water supply. A sample of water from the cistern into which the water is drawn after being used in manufacturing processes, to be again pumped into the main supply tank on the roof of the factory, was found upon analysis to contain more than three times the quantity of organic matter found in the water as drawn directly from the well, and this water also contained an excessive quantity of iron, giving it a slight turbidity and color, and causing the precipitation of a considerable quantity of iron. An analysis of a sample of water from the main tank on the building shows that it is a mixture made up in large part of water that has been returned to the tank after use in manufacturing processes, and that it contains a much greater quantity of organic matter and iron than is found in the water as originally drawn from the well.

In the opinion of the Board, the return of the water used for manufacturing into the water tanks through which water is supplied for drinking in this factory is very objectionable and should be prevented at once. The tubular well water, while not apparently polluted, is objectionably hard, and this water should not be supplied to the operatives for drinking.

Drinking water should be taken only from the pipes of the city water supply system.

There is danger, under the present arrangement, that if water is taken for drinking from the city water mains within the factory, it may be contaminated when the fire pumps are in operation either for a fire or for testing the apparatus; and the Board recommends that the connection for drinking water be made outside the factory or at such a point that there will be no possible danger that the water may be affected by water drawn from the canal or the river.

CUMMINGTON.

AUG. 3, 1911.

To Messrs. A. V. STEVENS and L. W. PETTINGILL, *Committee on Water Supply, Cummington, Mass.*

GENTLEMEN: — In response to your request of July 10, 1911, for advice as to a water supply for the village of Cummington, to be taken either from Mill Brook, Meadow Brook or Warner Brook, the State Board of Health has caused the sources indicated and other localities in the neighborhood of the village to be examined by one of its engineers and samples of the waters of these brooks to be analyzed.

Mill Brook drains a very large area, containing the village of Plainfield and many farm houses, and on account of the danger of pollution from dwelling houses on its watershed, this brook would not be a safe source from which to take water for domestic purposes.

Meadow Brook, though it has a smaller watershed, is open to the same objection, — that it is exposed to serious danger of pollution from dwelling houses on its watershed.

Warner Brook drains a watershed of about 0.25 of a square mile, judging from the State map, within the limits of which there is one dwelling house, and the danger of pollution of the water could easily be prevented. At the time the examination was made, however, there was very little water flowing in the brook, and in order to secure an adequate supply of water for the village from this source, it would be necessary to construct a storage reservoir of considerable size. The water of this brook would probably be of good quality, though the ground in the neighborhood of the brook is somewhat swampy, and the water of the reservoir would be likely to be affected at times by a noticeable taste and odor.

An examination of other localities in the neighborhood of the town shows that it may be practicable to obtain a supply of water from the ground in the neighborhood of Meadow Brook at a sufficient elevation above the village to furnish suitable pressure for all purposes. The conditions also appear to be favorable, judging from surface indications, for obtaining a sufficient supply of water of good quality from the ground in the neighborhood of the river southeast of the village.

A good ground-water supply would be much more desirable than a supply taken from surface sources, on account of its low temperature in summer and its freedom from color, taste and odor. The information now available to the Board is not sufficient to make it practicable to advise you definitely as to which of the sources mentioned seems likely to be the most appropriate for the village, and the Board advises a further investigation, with the assistance of an engineer of experience in water works construction, to determine the practicability of obtaining a supply of ground water from either of the sources indicated and the probable cost of such a supply, as compared with the cost of works for obtaining a sufficient quantity of water for the village from Warner Brook. When you have the results of further investigations to present, the Board will, if you so request, give you further advice as to a water supply for the village.

DIGHTON.

JUNE 1, 1911.

To the Committee on Water Supply of the Town of Dighton, MR. A. ELLERY BRIGGS, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on May 8, 1911, an application for advice as to a proposed water supply for the town of Dighton, in which you mention three possible sources: the first, a large well at the east base of Richmond Hill on land of William P. Eddy; the second, certain springs at the north base of Richmond Hill; and the third, a supply of ground water from the valley of Pine Swamp, so called, northwest of the village; and in response to this application the Board has caused the locality to be examined by its engineer.

The well near the eastern base of Richmond Hill is located between the highway bordering the west bank of the Taunton River and the New York, New Haven & Hartford Railroad. West of the railroad the hill rises abruptly and consists in this region largely of ledge, of which there is an extensive outcrop along the railroad. If any great quantity of water should be obtained from this well, it would have to come from the land bordering the river and probably largely by filtration from the river itself. There is a considerable population in this neighborhood which would be likely to affect unfavorably the quality of the water of the well, and water filtering from the Taunton River would be likely to be affected by salt water. There is no probability that water of good quality in sufficient quantity for the supply of Dighton could be obtained from this well.

The second source mentioned, the springs near the northerly base of Richmond Hill along the southerly side of the valley of Muddy Cove Brook, would be likely to furnish water of good quality, but it is very doubtful whether enough water could be obtained in this region for the requirements of Dighton after water has come into general use. It is possible that water could be obtained in considerable quantity from the ground on the northerly side of this valley farther up-stream, but a further investigation would be necessary to determine whether a suitable supply of water for the town could be obtained in this valley.

In the valley of Pine Swamp Brook — the third source mentioned — there is a large area of porous soil along the southerly side of the stream, which slopes rapidly to the valley of the brook and apparently yields a considerable quantity of ground water which flows from the base of the highlands in the form of springs. The conditions here appear to be favorable for obtaining an adequate quantity of water for the requirements of Dighton and it is likely that water obtained in this valley would be of good quality.

As a result of the examination thus far made the Board recommends that you cause tests to be made along the southerly side of Pine Swamp Brook, near the base of the ridge bordering this valley, to determine the feasibility of obtaining a supply of water for Dighton in this locality. In case the results should prove unsatisfactory, it will be advisable to make tests in the valley of Muddy Cove Brook, about a mile above the village. The Board will assist you in further investigations by making the necessary analyses of water and will, upon request, give you further advice in the matter when you have the results of further tests to present.

EASTHAMPTON.

OCT. 5, 1911.

To the Board of Water Commissioners, Easthampton, Mass.

GENTLEMEN: — In response to your request of Sept. 7, 1911, for advice as to the diversion of the water from above the reservoir on Mt. Tom into the reservoir, to be used in connection with water of the tubular wells, the Board has caused the reservoir to be examined and a sample of the water from a drain pipe draining the ground about it to be analyzed. It appears that it is proposed to construct a dam on the easterly side of the reservoir, seal up a drain pipe which now drains water from the ground about it and divert the water into the reservoir.

The results of the analysis show that the water flowing in the drain pipe at this time was of good quality, but the quantity flowing was very small, and it is impracticable to determine from this examination what the probable quality of the water entering the reservoir from the land about it would be if the changes proposed were made.

It is advisable to have the cause of the leakage in the reservoir carefully investigated by an engineer familiar with the construction of such works, to determine the best plan of preventing the serious loss of water by leakage, and such advice should be secured before any work is begun upon the improvement of the reservoir. If, after such an investigation, it is found practicable or desirable to admit ground water from the vicinity into the reservoir, the Board will make a further examination and advise you concerning it, if you so request. It is not advisable, in the opinion of the Board, under existing conditions, to admit into the reservoir any water draining from the ground about it which might include under some conditions surface water from the mountain side.

FAIRHAVEN (WELLS).

MARCH 2, 1911.

To the Board of Health, Fairhaven, Mass.

GENTLEMEN: — In response to your communication of Jan. 26, 1911, a further examination has been made of the well at 109 Spring Street, Fairhaven, and another sample of the water analyzed. The results confirm the previous analysis and show that the water of this well is grossly polluted and unfit for use.

The Board has also examined certain other wells in the vicinity, as follows: the well of Adolph Gubellini, 5 Delano Street; a well at 26 Town Lane; the well of Manuel Silva, Town Lane; a well at 113 Spring Street and another at 115 Spring Street. All of these wells are very badly polluted and their further use should be prevented.

It is doubtful whether water of suitable quality for drinking can be obtained from the ground in the neighborhood of these houses; but the public water supply is not far away, and for the protection of the public health a supply of good water should be provided in this locality.

FALL RIVER.

MARCH 2, 1911.

To the Reservoir Commission of the City of Fall River, MR. PHILIP D. BORDEN, *Clerk.*

GENTLEMEN: — The State Board of Health received from you on Nov. 18, 1910, an application requesting its approval of a proposed plan for protecting the purity of the water of North Watuppa Pond, the water supply of the city of Fall River, as outlined in a report by your engineer, Arthur T. Safford, C.E., submitted with your application. Your engineer has also submitted further plans showing in greater detail the works recommended.

The plan proposed is in brief the construction of an open channel or conduit along the westerly shore of North Watuppa Pond from Terry Brook at Meridian Street, in order to intercept the entire flow of water from Terry, Highland and Cress brook watersheds, and from the populated portions of the watershed south of the latter stream, and to discharge these waters into the South Pond near the Narrows. In connection with this plan it is proposed to construct a dam and create a reservoir on Highland Brook at Meridian Street, in order to store the flood waters in times of freshets and equalize the flow in the conduit; and it is proposed to create another small reservoir on Terry Brook for a similar purpose. The plan also provides for the diversion of certain small watersheds on the easterly side of North Watuppa Pond.

The total area of watershed on the westerly side of the pond that will be diverted under this plan will be 2.32 square miles, or 27 per cent. of the land surface within the present watershed of the pond. This area contains at present a population of about 2,700, or about nine-tenths of the total poulation now living within the watershed of North Watuppa Pond. Of the above number, about 1,000, or a little over one-third, are connected with sewers discharging outside the watershed. At present the pond is polluted by the drainage from these densely populated areas, including two large cemeteries located in this region.

In addition to the construction of a conduit and diversion of the populated areas on the west side of the pond, it is proposed to divert into the South Pond the waters of the two small streams known respectively as North and South Nat brooks, the watersheds of which lie near the New Bedford highway on the east side of the pond. These watersheds, which have an aggregate area of 0.37 of a square mile, or about 4 per cent. of the total land surface area within the watershed of the pond, contain a comparatively small population, but they include some objectionable sources of pollution, and it is deemed less expensive to divert their waters than to incur the expense of purchasing the lands from which the brooks are now polluted and the further expense of adequate future protection from these areas.

By the diversion of the water from the areas described, on the west side of the pond, and the small areas on the east side, it is estimated that the yield of the pond will be reduced to between 7,500,000 and 8,000,000 gallons per day; but it is suggested that by holding the pond at a level of 1 foot higher than at present, its yield in very dry seasons will be equal to 9,000,000 gallons per day, — a quantity about 50 per cent. in excess of the average amount supplied to the city in the last two years. For the future supply of the city, when a larger quantity of water becomes necessary than can be obtained from the North Pond, several plans have been considered, and it is found to be practicable to increase greatly the yield of North Watuppa Pond by diverting into it the waters from streams in adjacent watersheds to the east, either by gravity, as is possible in one or two cases, or by pumping.

The Board has caused North Watuppa Pond and its surroundings to be examined, and has considered your application and the report and plans presented. From the report it appears that several possible plans for protecting the purity of the water supply from North Watuppa Pond have been very thoroughly investigated, including a plan for removing all of the sewage from the areas at present occupied by buildings, and the purchase of the remaining lands; a plan for filtering the waters of the polluted areas before discharge into the pond; and a plan for the filtration of the entire water supply of the city, allowing the flow of the polluted watersheds to enter the pond as at present.

After a thorough study of all the available schemes and the preparation of plans of the necessary works in each case for the purpose of making reliable estimates of cost, the plan presented is deemed the most desirable and is found to be much more economical than any of the others. There is no doubt that the cost of the purchase and removal of all sources of pollution on the watersheds of Cress, Highland and Terry brooks and the adjacent populated areas would be excessive, and the diversion of the water of these polluted areas is the most effective plan of preventing the pollution of North Watuppa Pond; and the plan presented for the approval of the Board appears to be well adapted for this purpose.

It is of course impracticable to determine with certainty the maximum flow that may be expected from these areas at times of freshet, but by providing the reservoirs proposed on Terry and Highland brooks, the capacity of the diversion works is likely to be sufficient for the storage and removal of the greatest freshets, provided the level of the South Pond remains about as now maintained. The proposed storage reservoirs will not require any great amount of preparation for the purpose, since it is unlikely that their use will be required for more than a few days at very infrequent intervals. They can probably best be maintained as meadows, free from bushes, but they should be thoroughly ditched, so that they will drain quickly after use. It is probable that as the population increases on the areas diverted, the freshet flows will increase, and it may be found desirable to make further provision for the diversion of the water of these areas at some future time. It is desirable in any case that careful records be kept of the flow in the channel, so that further provision may be made for the removal of freshet flows if the observations indicate that further provision is necessary.

The diversion of the flow of the water of North and South Nat brooks on the easterly side of the pond appears to be the best plan of preventing the pollution of the pond from these watersheds. It is possible that the pollution of the pond from the buildings and dwellings within these watersheds could be prevented for the present by the enforcement of sanitary rules, and the lands eventually purchased, so that pollution might be prevented without diverting the water; but, considering the location of these areas, the plan of diverting the water appears to be the best practicable method of preventing further danger of the pollution of the pond in this region.

The chief disadvantage of the plan presented for protecting the purity of the water of North Watuppa Pond is the loss of water by the diversion of the flow from the polluted watersheds. It is probable, however, judging from the results of the investigations presented, that an ample supply of water to supplement the yield of North Watuppa Pond can be obtained from the sparsely populated watersheds adjacent to its watershed on the east, whenever a supplementary supply shall be required.

The Board approves the plan presented of diverting the waters of Terry, Highland and Cress brooks and the portion of the watershed of North Watuppa Pond south of the latter stream, by a conduit constructed along the westerly shore of the pond, as proposed, and discharging into South Watuppa Pond, including the storage reservoirs forming a part of this plan; also the plan of diverting the waters of North and South Nat brooks, from a small reservoir to be formed north of the New Bedford highway, through a pipe line into the South Pond.

When the plan proposed has been carried out, the city through its extensive purchases of land about the pond will control a very large portion (apparently about 72 per cent.) of the watershed that will still remain tributary to North Watuppa Pond. While the population upon the areas not controlled by the city is comparatively small, and by proper inspection serious danger of the pollution of the pond from these areas can be prevented, probably for many years, it appears to the Board very desirable that ultimately control of the entire watershed be secured by the city.

JULY 6, 1911.

To the Watuppa Water Board, Fall River, Mass., MR. JAMES J. KIRBY, *Clerk.*

GENTLEMEN: — In response to your request of June 8, 1911, stating that complaints have been made by several consumers of the fishy taste of the water, especially in the high levels of the city, the Board has caused the water of the lake and water drawn from faucets in various parts of the city to be examined.

At the time this examination was made very few organisms of any kind were found in the water of the lake, and no organisms of the kinds which most commonly cause objectionable tastes and odors in the waters of public water supplies. Inquiry at a number of the houses from which complaints have been received showed that in all cases the cause of complaint was apparently the turbid and muddy condition of the water, but nothing of importance was found in the samples collected at these places.

It appears that water is drawn from the mains to fill street-sprinkling cars, and the suggestion of your superintendent that the sudden drafts of large quantities of water from the pipes in this way may cause a stirring up of sediment in the pipes, very probably explains the conditions which have led to these complaints. If, upon further investigation, it is found that the cause of the difficulty is the one suggested, it is probable that it can be obviated either by filling the cars from a larger main or by using a storage tank of suitable size in connection therewith.

FOXBOROUGH (EAST FOXBOROUGH WATER SUPPLY DISTRICT).

OCT. 5, 1911.

To the Board of Water Commissioners of the East Foxborough Water Supply District, Foxborough, Mass., MR. CHARLES E. MARTIS, *Water Commissioner and Clerk.*

GENTLEMEN: — The State Board of Health has considered the plan of supplying water for domestic and other purposes to the East Foxborough Water Supply District from the water supply system of the Foxborough Water Supply District, as requested in your application of Sept. 28, 1911, and has caused the sources of supply of the Foxborough Water Supply District to be examined by one of its engineers.

The results of the examination show that the water of the wells from which the Foxborough Water Supply District has been supplied during the past twenty years is of very good quality for the purposes of a public water supply, and the yield of the wells appears to be ample for all requirements, including the additional quantity of water that will be necessary for the supply of the East Foxborough Water Supply District.

In the opinion of the Board, the plan is an appropriate one for providing a water supply for the East Foxborough Water Supply District, and the Board approves the source of supply and the location of the wells from which it is to be obtained, as required by the provisions of chapter 245 of the Acts of the year 1911.

FOXBOROUGH (STATE HOSPITAL).

FEB. 2, 1911.

To the Board of Trustees of the Foxborough State Hospital.

GENTLEMEN: — The State Board of Health received from you on Dec. 7, 1910, an application for its advice as to the use of water from certain springs situated, respectively, near the State road and near Pond Street in the town of Norfolk, as sources of water supply for the proposed institution to be constructed in that locality, which, it is expected, will eventually contain about 1,000 inmates; and in response to this application the Board has caused the locality to be examined by one of its engineers and samples of the water of the springs to be analyzed.

The results of the analyses indicate that these waters are naturally of very good quality for domestic purposes. Neither source is likely, under present conditions, to yield enough water for the requirements of the proposed institution, but there is little doubt that by deepening the springs or providing a system of tubular wells or other suitable collecting works in their neighborhood, an adequate quantity of water for all requirements can be obtained at either location. The best plan of developing a water supply for the institution will probably be to take water from a system of tubular wells located on the upland near the edge of the low ground, either in the neighborhood of the Fales Spring or near the Whiting Spring, and, judging from surface indications, the conditions are favorable for obtaining a ground-water supply at other places within the limits of the grounds to be acquired by the institution.

It is very important before beginning the construction of buildings to make further tests by means of tubular wells to determine definitely the location from which a water supply can best be obtained. These tests should be made under the direction of an engineer of experience in matters relating to water supply. After a location has been selected, the locations of the buildings and sewage disposal areas or other works can be so chosen that danger of the pollution of the water will be avoided.

The Board will, if you so request, assist you in further investigations as to a source of water supply by making the necessary analyses of water, and will give you further advice in this matter when you have the results of further investigations to present.

MARCH 2, 1911.

To the Foxborough State Hospital, Foxborough, Mass., IRWIN H. NEFF, M.D., *Superintendent.*

GENTLEMEN: — In accordance with your request of Feb. 10, 1911, for an examination of the water of two wells, one on the Fales estate and the other on the McMorrow estate, in Norfolk, with a view to the use of these wells as a temporary source of water supply during the construction of the buildings for the new hospital, the Board has caused the wells indicated to be examined and samples of their waters to be analyzed.

The well on the Fales estate is situated near a cow barn, with sources of pollution at no great distance, and the brick curbing about the well is rather loosely constructed, so that surface water may enter. It is probable if the lining of the well were laid in cement, so as to exclude surface water, water could be obtained from this well which might be used with safety for drinking; but owing to the nearness of possible sources of pollution, the water should be examined from time to time and its use discontinued if deterioration occurs.

The water of the well on the McMorrow estate is so very foul that its further use should be prevented at once.

FRAMINGHAM.

MAY 27, 1911.

To the Board of Water Commissioners of the Town of Framingham, Mass.

GENTLEMEN: — The State Board of Health has considered your application for advice as to making further tests for a water supply by driving test wells at certain points in the easterly part of the town, and has caused the localities indicated to be examined by its engineer.

The places at which it is proposed to make the tests are shown upon a plan submitted with your application and are described as follows: —

> *First.* — A place about midway between the dam at Lake Cochituate and the Saxonville branch of the Boston & Albany Railroad.
>
> *Second.* — A place on the extreme northerly point of Lake Cochituate near the Wayland town line, on the north side of a ridge which is about 30 feet above the water of the Lake, and slopes down to a meadow where we propose to test.
>
> *Third.* — A place near the New York, New Haven & Hartford Railroad about ¾ mile north of the North Framingham station, in what might be termed the watershed of the Landham Brook, all within the town of Framingham. We propose to drive six test wells in each place, which we think would give us a fair idea of the amount and quality of water in each locality.

Of the places mentioned the most favorable in which to make further tests for a ground water supply, judging from the surface indications, appears to be the location in the neighborhood of Landham, or Hopp, Brook, in the vicinity of the Framingham and Lowell branch of the New York, New Haven & Hartford Railroad, about a mile north of the North Framingham railroad station. At this point the soil appears to be very coarse and porous, judging from surface indications, and the locality is free from sources of contamination which might injure the quality of the water. The area of the watershed which might contribute to wells in this locality is somewhat limited, but if there is a deep and extensive stratum of porous soil beneath the surface in this region it is not unlikely that a sufficient quantity of water could be obtained here for the supply of the town for several years in the future. If the earlier tests indicate that the conditions are favorable for a large yield of ground water further tests can then be made to determine the probable quantity and character of the supply obtainable.

Of the other two locations, both of which are in the neighborhood of Lake Cochituate, the more favorable one in which to make tests for a ground water supply is that near the northerly end of the lake. It is probable that wells driven in the valley between the lake and the low ground near the Sudbury River would yield a large quantity of ground water, and it is worth while, in the opinion of the Board, to make preliminary tests in this region to determine the depth and extent of porous soil in order to compare the conditions with those found at other places. At the location near the outlet of Lake Cochituate the conditions are less favorable than at the other places indicated, and it is somewhat doubtful whether enough ground water could be obtained in the neighborhood of the outlet of Lake Cochituate to supply the present requirements of the town. There is danger, also, that the quality of the water in this locality might be affected by sewage effluent flowing through Bannister Brook, and under the circumstances it will probably not be desirable to make tests in this location unless the results elsewhere are unfavorable.

The Board will assist you in further investigations if you so request by making the necessary analyses of water from the test wells, and when the results of further preliminary tests are available will advise you as to the results.

GLOUCESTER (WELL IN EAST GLOUCESTER).

DEC. 22, 1911.

To the Board of Health of the City of Gloucester.

GENTLEMEN: — In response to your request for an examination of the water of a well on Mt. Pleasant Street in East Gloucester, used as a source of drinking water by inhabitants in the neighborhood, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The well is located in a populous section of the city and there are a number of sources of pollution in its immediate neighborhood. The results of the analysis show that the water is grossly polluted, and the Board recommends that its further use be prevented.

GREAT BARRINGTON (HOUSATONIC).

JUNE 1, 1911.

To the Board of Health, Great Barrington, Mass.

GENTLEMEN: — In response to your request of May 19, 1911, stating that complaints are being made regarding the condition of the drinking water supplied in the village of Housatonic and requesting an examination of the same and advice as to its condition, the State Board of Health has caused the source of supply to be examined and a sample of the water to be analyzed.

The results of the examination show that the water of Long Pond, from which the supply is obtained, is at present affected by the presence of considerable numbers of the organism Uroglena, which imparts to the water a very disagreeable taste and odor, and it is to the presence of this organism that the objectionable condition of the water supply during the past months has doubtless been due. The use of water containing this organism, for domestic purposes, is not known to be injurious to health, and there is no known method of preventing its appearance and growth in the waters of ponds and reservoirs. While it is present in the water, it is not advisable to flush the pipes, and flushing should be postponed, under these conditions, until the organism has disappeared from the pond.

The watershed of Long Pond is mountainous and contains but few inhabitants, but the level of the pond appears to have been raised, and there are indications that there is considerable organic matter in its bottom. It is possible that by permanently lowering the level of the pond a few feet, the condition of the water would be improved, and there is no doubt that the water could be purified satisfactorily by filtration.

JUNE 1, 1911.

To the Housatonic Water Works Company, Housatonic, Mass.

GENTLEMEN: — In response to a request from the Board of Health of the town of Great Barrington the State Board of Health has caused an examination to be made to determine the probable cause of the objectionable condition of the water complained of during the past few weeks, and the results of this examination are given in a communication addressed to the Board of Health, a copy of which is enclosed herewith.

The Board recommends that the water company investigate carefully the condition of the bottom and shores of the pond, in order to determine the practicability of improving the condition of the water by cleaning the shores and bottom or by lowering the level of the water, and recommends further that you investigate at the same time the probable cost of purifying the water by filtration. These investigations should be made under the direction of an engineer of experience in such matters, and when the results of the investigations are available the Board will, if you so request, give you further advice as to improving this water supply.

GREENFIELD (FIRE DISTRICT No. 1).

APRIL 6, 1911.

To the Board of Water Commissioners of Fire District No. 1, Greenfield, Mass.

GENTLEMEN: — The State Board of Health received from you on March 24, 1911, an application for its advice relative to a proposed plan for obtaining an additional water supply for the Greenfield Fire District from the ground near the easterly side of Green River about half a mile north of the present pumping station on that stream and south of the highway bridge near the boundary between Greenfield and Leyden, in which your plan is outlined as follows: —

> It is proposed to collect water here by sinking a large well about 150 feet from the river. The area of infiltration may be increased by two methods if the well fails to furnish the required amount of water. By building a low dam across the river at a point just north of the bridge and laying a pipe water can be turned on to the area between the well and the river, or filter galleries parallel with the stream may be connected.

The application is accompanied by a plan showing the contour of the ground in the region in which it is proposed to locate the well or other collecting works and the location of test wells which have been sunk in this region to determine the depth of porous soil and the character of the ground water.

The Board has caused the locality to be examined by its engineer and samples of water sent in by you from the test wells to be analyzed.

The results of the analyses indicate that the ground water of this locality is of very good quality for domestic purposes. The tests show that the wells penetrated a porous soil several feet in depth extending below the level of the river, and these conditions, — taken in connection with the character of the soil in the region about the proposed wells, which appears to be favorable for the absorption of a considerable portion of the water falling upon the ground, — are favorable for obtaining a large quantity of water from wells or other collecting works in this region. In case, however, the quantity of water obtainable from wells or other works should not prove sufficient for the requirements of the town at all times when used in connection with the present sources, the plan of diverting water from Green River above the highway bridge upon the ground in the neighborhood of the proposed wells or filter galleries affords a means of greatly increasing the supply of ground water in case of need. If the water from the river is used as proposed, the trenches or beds to which it is applied should be located 100 feet or more from the wells or other collecting works.

In the opinion of the Board, the plan is an appropriate one for increasing the water supply of the town of Greenfield, and used in connection with your present sources of supply is likely to provide an adequate quantity of water for all requirements of the town with reasonable use until the population becomes much larger than at the present time.

GROTON (WEST GROTON WATER SUPPLY DISTRICT).

OCT. 5, 1911.

To the Board of Water Commissioners of the West Groton Water Supply District.

GENTLEMEN: — In response to your application of Oct. 4, 1911, for the approval of the use of a system of tubular wells located near the easterly bank of the Squannacook River about a mile and a quarter above the village of West Groton, the Board has caused the proposed sources of supply to be examined by one of its engineers and samples of the water to be analyzed.

The results of the examination show that the water of the wells from which it is proposed to take the supply was of very good quality for domestic purposes. The results of the pumping test made by pumping continuously from eight wells in this locality for a period of about four days indicate that an ample supply of water can be obtained from wells in the locality proposed.

The Board, acting under the provisions of chapter 641 of the Acts of the year 1911, approves the proposed source of supply and the location of the wells from which it is to be derived.

HARDWICK.

MAY 4, 1911.

To the Water Supply Committee of the Town of Hardwick, MR. JOEL L. POWERS, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on April 14, 1911, an application for advice as to a proposed water supply for the schoolhouse, library, town hall and a fountain in the center of the town, and has caused the sources of supply which you have mentioned to be examined and samples of their waters to be analyzed.

One of the sources indicated is a tributary of Danforth Brook, on which it is proposed to construct a reservoir in Page Meadow, so called, a short distance below the road leading from Hardwick to Greenwich and about half a mile north of the village. An analysis of a sample of the water flowing in the brook at this point shows that it is affected by the vegetable matter in the swampy ground through which it flows, having considerable color and a larger quantity of organic matter than is found in good surface waters. It is said that the brook does not dry up in summer, and if that is the case it is possible that with a reservoir of considerable size it would be possible to obtain a small quantity of water from this source at all times even in dry seasons. It is not probable, however, that enough water could be obtained here for all the requirements to which the water would be likely to be put if a supply should be introduced into the village for the purposes indicated in your application, and the quality of the water would probably not be satisfactory for some of the purposes for which it would be used.

Another possible source indicated by your committee is a spring near Page Meadow now used for the watering of cattle. An analysis of the water of this spring shows that it is of better quality than the water of the brook, and it is probable that if the spring water were collected in a deep covered basin it would be of good quality for domestic purposes. It is not probable, however, judging from the information available, that this spring would yield a sufficient quantity of water for the requirements of the village, as stated in your application.

Another source indicated is a spring on the slope of Poverty Hill, about half a mile northwest of Page Meadow, but the quantity of water which this spring supplies is quite limited and it is not probable that it would furnish enough water for the buildings, fountain and other requirements of the village.

It is possible that by constructing a deep basin at the site of the spring in Page Meadow and diverting into it the waters of the small springs in its neighborhood and utilizing the flow of the spring near Poverty Hill, enough water might be obtained for the purposes mentioned in your application. It is understood, however, that there has been a shortage of water in the village during the summer season in the past two years, and it is very desirable that in introducing a water supply enough water be secured to provide in addition to the town hall, fountain, etc., enough water for the requirements of the householders in the village for domestic purposes. It is probable that enough water for this purpose can be obtained from the ground in the valley of Danforth Brook or one of its tributaries along the northwesterly side of Poverty Hill, and the Board recommends that an examination be made of that locality to determine the practicability of obtaining there an adequate quantity of good water for all the requirements of the village. The Board will, upon application, assist you in further investigations as to securing a water supply for the village by making the necessary analyses of water and will advise you as to any other sources that you may wish to consider.

HINGHAM (SPRING IN SOUTH HINGHAM).

AUG. 3, 1911.

To H. O. SPALDING, M.D., *Hingham, Mass.*

DEAR SIR: — In response to your request for an examination of the water of a spring at South Hingham, which you propose to supply to the public for drinking, the Board has caused the spring and its surroundings to be examined and a sample of the water to be analyzed.

The results of the examination show that the spring is located in low ground, but several hundred feet from any dwelling house or other possible source of pollution, and the results of the analysis show that the water, though showing some evidence of previous pollution, has been thoroughly purified in its passage through the ground and is of good quality for domestic purposes. While the region about the spring remains free from sources of pollution, as at present, it is probable that it will continue to furnish water of good quality.

HOLYOKE (SPRING).

SEPT. 7, 1911.

To the Board of Health of the City of Holyoke.

GENTLEMEN: — The State Board of Health has considered your request for an examination of the so-called spring in one of the playgrounds in Holyoke and advice as to whether the water is free from pollution and safe for drinking purposes, and in accordance with this request the Board has caused the spring and its surroundings to be examined and has collected information, so far as practicable, regarding its probable source.

From this information it appears that the so-called spring comes out of a pipe in the southwest corner of a playground opposite Springdale Avenue. There appears to be no record of this pipe in the sewers and drains of the city, so far as the Board can learn, and the source of the water cannot be definitely ascertained at the present time. The source of the spring is apparently in a thickly populated section and there have been indications in the past that at times of very heavy rain surface water and even sewage find entrance to the pipe at some point.

Under these circumstances this so-called spring must be regarded as a very dangerous source from which to take water for drinking, and the Board recommends that the possibility of its use for that purpose be prevented, and that the outlet of the pipe be lowered, so as to be beneath the surface of the water in the river at all times.

HUDSON.

JUNE 1, 1911.

To the Commissioners of Public Works of the Town of Hudson, Mass.

GENTLEMEN: — The State Board of Health received from you on April 28, 1911, a petition for its consent to and approval of the purchase or taking of certain lands within the watershed of Gates Pond, so called, in the town of Berlin, for the purpose of protecting and preserving the purity of the water of said pond which is used as a source of water supply for the town of Hudson.

In response to this petition the Board gave a public hearing, as required by chapter 499 of the Acts of the year 1908, at its office, Room 143, State House, on Thursday, June 1, 1911, due notice of said hearing having been given by publication in newspapers in the town of Hudson. After the hearing, at which no one appeared to oppose the taking of the lands in question by said town, and after causing an examination of the lands in question to be made, the Board upon consideration voted to consent to and approve of the purchase or taking by the town of Hudson of certain lands in the town of Berlin now or formerly of Frank C. Brigham, Sidney M. Robinson, Henry J. Sawyer, Frederick A. Fosgate and the Charles E. Bennett estate, said lands having an aggregate area of 23.2 acres more or less, and being bounded, measured and described as follows: —

A description of a tract of land, situated in the southeasterly part of Berlin, Mass., bordering on Gates Pond, so called, which the town of Hudson proposes to purchase of Henry J. Sawyer for the improvement of its water supply.

Said tract contains nineteen and 5/10 acres, more or less, and is bounded and described as follows: —

Beginning at a stone monument at the most easterly corner of the same at land of the town of Hudson and running thence by land of said town North 14° West two hundred and forty three and 5/10 feet to land of H. H. Harper; thence by land of said Harper North 88° 45′ West, by the stone wall, seven hundred and eighteen feet to an angle; thence by land of said Harper and the stone wall, South 38° West five hundred and eleven feet to an angle; thence by the same land and the wall, South 5° 45′ West two hundred and ninety feet to an angle; thence by the same land and wall South 12° West three hundred and five and 5/10 feet to an angle; thence by land formerly of Joseph J. Randall and the wall South 80° 20′ East two hundred and thirty two feet to an angle; thence by the last mentioned land and the wall North 70° 30′ East nine hundred and sixteen feet to land of said town of Hudson; thence by land of said town North 3° 40′ East one hundred and three feet to a stone monument; thence by the last mentioned land

North 14° 45′ East two hundred and eighty four feet to the corner and bound first mentioned. Being the same premises shown on a plan of land owned by Henry J. Sawyer, drawn April 1911, Welsh & Parker, C. E.

A description of a tract of land, situated in the Southeasterly part of Berlin, Mass., bordering on Gates Pond, which the Town of Hudson proposes to purchase of Frederick A. Fosgate for the improvement of its water supply.

Said tract contains One Hundred and Thirty square rods, more or less, and is bounded as follows: —

Beginning at the southwesterly corner of the same at a stone monument at land of the Town of Hudson and land of Frank C. Brigham and running thence by land of said Town North 88° 30′ East One Hundred and forty eight and 5/10 feet to a stone monument at a corner; thence by land of said Town due North Two Hundred and forty five feet to a stone monument at a corner; thence by land of said Town South 84° 40′ West One Hundred and fifty feet to a stone monument at a corner at land of said Frank C. Brigham; thence by land of said Brigham due South Two Hundred and twenty seven feet to the corner first mentioned, with a cottage thereon.

Being the same premises shown on a plan of land owned by Frederick A. Fosgate, drawn by Welsh & Parker, C. E., April 1911.

Copy of description in a deed dated April 5, 1911, given by Walter E. Carver and Sidney M. Robinson to the town of Hudson; — a certain parcel or tract of land, situated in the southeasterly part of Berlin in said Commonwealth, on the shore of Gates Pond, containing Thirty seven rods, more or less, bounded and described as follows: —

Beginning at a stone bound at the southwesterly corner of the same, at land of grantee, the same being a driveway leading to a town road, and running thence by land of grantee northerly ninety seven and 4/10 feet to a stone bound at said Gates Pond; thence by said Pond Easterly one hundred feet to a stone bound; thence by land of grantee Southerly one hundred six and 5/10 feet to a stone bound at said driveway; thence by said driveway Westerly one hundred feet to the corner first mentioned.

Together with a right to pass and repass with teams or otherwise, at any and all times, over said driveway to the town road.

Subject to whatever rights the said Town of Hudson may have to use the northerly portion of said premises in connection with its water supply.

Excepting and reserving, however, the building now standing on said premises with the right to remove the same until July 1, 1911.

Being the same premises conveyed to us by deed of Frederick A. Fosgate, dated June 16, 1904 and recorded with Worcester District Deeds Book 1825, page 286.

A description of a tract of land, situated in the Southeasterly part of Berlin, Mass., bordering on Gates Pond, so-called, which the town of Hudson proposes to purchase of Frank C. Brigham, for the improvement of its water supply.

Said tract contains Ninety Five rods, more or less, and is bounded as follows, —

Beginning at a stone monument at the southwesterly corner of the same, at land of the town of Hudson and land of Ella G. Fosgate, and running thence by land of said town North 74° 28′ East one hundred and forty two feet to a stone monument at an angle; thence by land of said Town South 61° 27′ East fifty eight and 2/10 feet to a pipe bound at an angle; thence by land of Frederick A. Fosgate due North one hundred and forty six feet to a pipe bound at land of Ella G. Fosgate; thence by land of said Ella G. Fosgate South 89° 30′ West one hundred and eighty nine feet to a pipe bound at a corner; thence by land of said Ella G. Fosgate South 0° 30′ East one hundred and fifty five and 8/10 feet to the corner first mentioned, with a cottage thereon.

Being the same premises shown on a plan of land owned by Frank C. Brigham, situated in Berlin, Mass., made in April, 1911, Welsh & Parker, C.E.

A description of a tract of land, situated in the Southeasterly part of Berlin, Mass., bordering on Gates Pond, so called, which the town of Hudson proposes to purchase of the heirs of Charles E. Bennett for the improvement of its water supply.

Said tract contains two and 1/10 acres, more or less, and is bounded and described as follows, —

Beginning at the Southeasterly corner of the same at land of said town and running thence by land of said town North 80° 30′ West two hundred and one and 5/10 feet to a stone monument; thence by land of said town South 76° West one hundred and thirty six and 5/10 feet to land of Charles G. Schirmer; thence by land of said Schirmer North 1° 30′ East two hundred and sixty two feet, by the stone wall, to a corner at land of Ella G. Fosgate, thence by land of said Fosgate South 83° 40′ East four hundred and three feet to a corner; thence by land of said Fosgate and land of said town South 21° 15′ West two hundred and thirty two feet to the corner first mentioned, with a cottage and stable thereon.

Being the same premises shown on a plan of land in Berlin, Mass., drawn April, 1911, Welsh & Parker, C.E.

HUNTINGTON (HUNTINGTON FIRE DISTRICT).

JAN. 5, 1911.

To Messrs. JOSEPH FLEURY and JOHN DOYLE, *Water Commissioners of the Huntington Fire District, Huntington, Mass.*

GENTLEMEN: — The State Board of Health received from you on Dec. 15, 1910, the following application for advice as to a proposed water supply for the Huntington Fire District: —

We hereby make application for your advice and approval of the waters of Roaring Brook sometimes called Taylor Brook situated in the southeasterly part of the town and easterly of the Westfield River to be taken and used by the inhabitants of the Huntington Fire District as a public water supply.

In response to this application the Board has caused the brook and its watershed to be examined and a sample of the water to be analyzed. The results of the examination show that there are at the present time within the watershed of Roaring Brook, above the point at which it would naturally be taken for the water supply of Huntington, about 40 dwelling houses in a drainage area of a little over 4 square miles. Many of these dwelling houses are so situated that pollution from them undoubtedly at times finds its way into the brook. In the opinion of the Board, there is no practicable plan by which the Huntington Fire District can prevent danger of the pollution of the brook from these places so effectively that the water of this stream may safely be used for domestic purposes unless by filtration, the cost of which, under existing conditions, would be large; and the Board is unable to recommend the use of this brook as a source of water supply for the Huntington Fire District.

HYDE PARK.

JAN. 5, 1911.

To the Board of Water Commissioners of the Town of Hyde Park.

GENTLEMEN: — The State Board of Health received from you on Dec. 12, 1910, the following communication requesting its advice as to the plan described therein for improving the water supply of the town of Hyde Park: —

The water commissioners of the town of Hyde Park have considered your communications of May 19 and Dec. 1, 1910, addressed to the board of health of Hyde Park, copies of which we have on file, in which you state that the water of the Neponset River wells has become so polluted as to be unfit for use for domestic purposes and recommend that an adequate supply of good water be secured as soon as possible.

This Board is considering the matter of improving the water supply of Hyde Park. We started investigation soon after the town took possession, April 1, 1910. Mr. Wm. S. Johnson, hydraulic and sanitary engineer, has been making a study of the whole subject to determine the best means to be adopted to improve the water supply, and the cost of the same. As a result of these investigations it appears that the cost of taking water from the metropolitan system would be so much greater than the cost of maintaining the present works, that it would be necessary either to make a substantial increase in the prices charged for water or to materially increase the tax rate of the town.

It appears from the investigations of our engineer that water of good quality and in sufficient quantity to supply the town, without the use of water from the Neponset River wells, can be obtained from the Mother Brook wells by constructing filters on the gravelly soil near the junction of Milton and River streets, on land already owned by the town, and pumping water from Mother Brook upon these filters, the water to be collected in the present wells and in additional wells to be driven in their immediate vicinity. The cost of maintaining these works will entail no additional expense upon the town, as the amount saved by discontinuing the use of the Neponset River plant would be enough to maintain the purification works at Mother Brook, including interest and payments on bonds.

It is proposed to take water from Mother Brook above the filter beds of the Cochrane Manufacturing Company and to pump it to four filter beds having a combined capacity of 1½ acres. The soil of the area where the filters would be constructed consists of coarse gravel to a depth of from 15 to 20 feet, then a stratum of coarse sand extending over most of the area, and beneath the sand another stratum of coarse gravel. It is proposed, after removing the loam and subsoil and leveling the beds, to put 12 inches of good filtering sand above the gravel. The shortest distance which the water would travel through the soil in passing from the filter to the wells would be about 150 feet.

If these works should be constructed, it is proposed to fill in the brooks and ditches in the meadow in which the wells are driven, and to fill in around the wells to above the high-water mark, so as to prevent the possibility of water entering the gravel stratum directly, except through the filters. It is also proposed to provide for the removal of all sewage from the few houses in the vicinity of the wells.

Works for obtaining water in this way can undoubtedly be completed by June 1, 1911, and we are informed by the officials of the Metropolitan Water Board that it would take a considerably longer time to get a supply from the Metropolitan District.

Before reporting the matter to the town, the water commissioners desire to obtain the advice of your Honorable Board with reference to the adequacy of the plans proposed. Details in regard to the proposed plans will be submitted to you by our engineer.

The results of the investigations, together with the plan of the proposed works, have been presented by your engineer, and the Board has caused the locality to be examined and has considered the information presented.

It is probable that water from Mother Brook can be efficiently purified by filtration through sand and the yield of the Mother Brook wells very materially increased by discharging filtered water from Mother Brook into the ground near the wells, as proposed; but it would be necessary to provide a much deeper layer of good filtering sand at the surface of the filters, to insure the purification of the water, since experience has shown that water flows through the ground very rapidly at some places in this region.

The plan of filling the ditches and raising the level of the ground about the wells, which is now covered at times with water from Mother Brook, and disposing properly of the sewage discharged into vaults and cesspools at houses near the wells, would remove some of the sources from which they may have been polluted in the past, but other objectionable conditions which may affect unfavorably the quality of the water of these wells would still remain, among which may be mentioned the sewers in streets about the wells, leakage from which may at times contaminate the ground water, and the danger that imperfectly filtered water from Mother Brook may find its way through the ground to the wells. There also appears to be danger that new sources of pollution may be established on lands near the wells not now owned by the town, and if this plan should be adopted, the control of a larger area of land would probably be found necessary for the protection of the water of the wells.

The wells are located in a region already populous, where there is likely to be a steady and possibly rapid growth of population in the future, and in view of the conditions at present existing about the wells and which would still exist after the proposed improvements had been made, it appears to the Board that there would still be uncertainty as to the present and still more as to the permanent safety of this water for drinking, and the plan is not, in its opinion, a desirable one for the town to adopt.

The possibility of obtaining an adequate supply of good water from the ground at some place in the Neponset River valley above Hyde Park is referred to by your engineer, but, owing to the probability that the cost of such a scheme would be greater than of the plan presented, it has not as yet been investigated.

Apparently the plan of taking a supply of water from the Metropolitan Water District is not an unduly expensive one, and while the cost of a supply from this source would, according to the estimates presented, be considerably greater than the cost of the development of a supply from the Mother Brook wells, as proposed, there are considerable economies that would result in the taking of metropolitan water which would tend to reduce its comparative cost, while the expense of improving and maintaining the purity of the Mother Brook wells may be greater than is now anticipated. Moreover, it is not unlikely, as has been found in other cases, that a very material increase in the income of the water department would follow the introduction of a supply of good water, such as would be obtained from the metropolitan system.

In view of all the circumstances, the Board believes that it will be for the best interests of the town of Hyde Park to take water from the metropolitan system in the beginning, rather than to attempt to improve the quality and add to the quantity of water obtainable from the Mother Brook wells, a source which is likely to continue to be of uncertain quality and which can be used probably in any case only for a limited number of years.

MARCH 23, 1911.

To the Board of Health of the Town of Hyde Park.

GENTLEMEN: — The analyses of water from the wells near Neponset River which have been made during the months of February and March of this year show greater pollution than in the same months of last year, and the analyses of water from the wells near Mother Brook show about the same characteristics as those made in the same months last year.

The characteristics of the water from both sources are expressed in the communication of Dec. 1, 1910, addressed to your Board as follows: —

> The water of the Neponset River wells has become so polluted as to be unfit to be used for domestic purposes, and its use should be discontinued. The degree of its pollution has followed dangerously near to and coincident with the degree of pollution of Neponset River and the prevalence of typhoid fever has been coincident with their common pollution.
>
> The water of the new wells situated near Mother Brook does not show by chemical analysis pollution beyond that of many driven well supplies, and its quality does not fluctuate in general with that of Mother Brook, but there are some local conditions that render this water suspicious. The wells situated nearest to privies on Paradise Lane give water more polluted than those farther away. The water from Mother Brook sometimes flows over land surrounding the wells and enters springs which are probably feeders of some of the wells. After a heavy rain in September last the water from these wells contained a much larger number of bacteria than usual, and there were some bacteria characteristic of sewage.
>
> In view of these conditions your recommendation that the water of the public water supply be boiled before drinking should, in the opinion of the Board, be continued.
>
> The Board recommends that an adequate supply of good water be secured as soon as possible.

HYDE PARK (SPRING WATERS).

MARCH 2, 1911.

To the Board of Health of the Town of Hyde Park.

GENTLEMEN: — In accordance with your request of Jan. 20, 1911, for an examination of the waters of certain springs sold for drinking in Hyde Park, and advice as to the quality of these waters, the State Board of Health has caused the springs which are located in Massachusetts, mentioned in the list submitted by you, to be examined and samples of their waters to be analyzed.

The Nobscot Mountain Spring is located on one of the slopes of Nobscot Mountain in Framingham, and its watershed is uninhabited. An examination of the water, both from the spring and from a carboy delivered for use, shows that it is of very good quality.

Simpson's Spring is located in South Easton, in a locality free from buildings or other possible sources of pollution. This water is also of good quality, both at the spring and as sold in the town.

The Shawmut Spring is located in a sparsely populated district in West Quincy, and the water, as shown by analysis, is of good quality. Certain changes are desirable in the conditions about this spring and in the manner of filling and handling the receptacles in which the water is delivered to consumers, in order to prevent danger of its pollution.

The Milton, or Copeland's, Spring is located in the southwesterly part of Milton in a populous region, the effect of which is shown in the mineral contents of the water. As found at the time of the examination the water, as taken from the spring itself, was probably safe for drinking. At this spring also certain changes are desirable in the manner of filling the receptacles in which the water is delivered, if danger of pollution is to be prevented.

The Maple Grove, or Davenport, Spring, so called, is a tubular well about 40 feet from Sprague Pond near Sprague Street in Readville. The analysis shows that the water has evidently at some time been greatly polluted, but at the time the examination was made it was being quite well purified in its passage through the ground before entering the well and was at this time probably safe for drinking. A sample collected from one of the vessels in which the water is sold showed a slightly greater quantity of organic matter than was found in the water as drawn from the spring, indicating that more care is required in the handling of this water if its use is to be continued.

LAKEVILLE.

JUNE 8, 1911.

To the Board of Selectmen, Lakeville, Mass.

GENTLEMEN: — In response to your petition the Board, after a hearing, has decided to make to the city of Taunton these recommendations as to boating, fishing and ice cutting on Assawompsett Pond: —

That no permits be granted for boating, fishing or ice cutting on that portion of Assawompsett Pond which lies within one-fourth mile of the intake of the Taunton water works at Assawompsett Pond, except that boatmen be allowed to cross these waters in passing from one part of the pond to another;

That no permits be required hereafter for boating, fishing or ice cutting on the portion of the pond east of a line drawn from the Nemasket River to a point one-fourth mile west of the mouth of Tamett Brook.

LITTLETON.

OCT. 5, 1911.

To the Board of Water Commissioners of the Town of Littleton.

GENTLEMEN: — The State Board of Health has considered your application of Sept. 13, 1911, for its approval of the use as sources of water supply of certain tubular wells located on the westerly side of Beaver Brook, a short distance south of the village of Littleton, and has caused the locality to be examined by one of its engineers and samples of water from test wells in this locality to be analyzed.

The results of the analyses of samples of water collected from time to time during a pumping test made early in September show that the water is of good quality for domestic purposes, and the quantity obtained from the wells during the test, taken in connection with the observations of the height of the ground water at the beginning and end of the test, indicate that an adequate supply of water for all the requirements of Littleton can be obtained from the ground in this locality.

The Board approves the use of water from these wells and their location under the provisions of chapter 617 of the Acts of the year 1911.

It is advisable that, in view of the nearness of the source of supply to the village, a considerable area of land be secured about the wells, in order to protect them from pollution.

LOWELL.

MAY 4, 1911.

To the Lowell Water Board, Lowell Mass., Mr. J. W. CRAWFORD, *Secretary.*

GENTLEMEN: — In response to your request of May 1, 1911, for advice as to whether the use of certain lands formerly connected with the city farm on Chelmsford Street as a location for a contagious disease hospital is likely to affect the water of the Cook wells, so called, the Board has caused the locality to be examined by one of its engineers and has considered the information presented.

It appears that the site selected for the hospital is on the easterly side of Chelmsford Street north of the driveway leading from Chelmsford Street to the city farm, and that the building is to be connected with the public sewer in Chelmsford Street, and all modern apparatus for thorough disinfection and sterilization is to be installed. The hospital will be located more than a quarter of a mile from the wells, and, considering the circumstances, in the opinion of the Board the construction of the hospital, as proposed, on the lands indicated would not be a menace to the purity of the water of the Cook wells.

SEPT. 7, 1911.

To the Lowell Water Board, Lowell, Mass.

GENTLEMEN: — The State Board of Health received from you on July 20, 1911, the following request for advice as to the use of water from the Cook wells for the supply of the city of Lowell: —

> The water board desire an opinion from the State Board of Health as to the advisability of continuing to use the Cook Wells Plant. We have been pumping water from this plant since March, nearly six months, and really need this supply until the fall rains, as the Boulevard Plant is hardly sufficient to supply the needs of the city; and this board wishes to know if it will be a menace to the health of the people using this water to continue its use for a few weeks longer.

Before the investigations had been begun, however, the use of the Cook wells was discontinued. An examination of the water at the source when not in use would not furnish adequate information as to the probable effect of the water when delivered constantly through the distributing pipes; consequently the Board instituted inquiries as to the condition of the people in the section of the city that was supplied with Cook well water during the past six months and there found invalids whose condition may, in the opinion of the physicians, have been aggravated by lead poisoning.

The results of these inquiries confirm the opinion of the Board formerly expressed to you, — that Cook well water drawn through lead pipes is a poison, and its use is a serious menace to the health of the people. Continuing to supply this water to the citizens under present conditions would, in the opinion of the Board, be wilful injury to the health of the people.

OCT. 5, 1911.

To Mr. PHILIP S. MARDEN, *Managing Editor, Lowell Courier-Citizen, Lowell, Mass.*

DEAR SIR: — The State Board of Health received from you on Sept. 25, 1911, a communication stating that considerable anxiety exists in Lowell as to the safety or danger of using the present city water supply for drinking purposes, and requesting the opinion of the Board relative thereto.

The deterioration in the quality of the water supplied from the driven wells near the Boulevard, which was referred to in a communication to the Lowell water board last year relative to taking additional lands in the region of the wells, has continued and become more marked during the present year. The quantity of iron present in the water has increased and it has deteriorated in other ways until it has become objectionable for many domestic uses. The deterioration is probably due to the imperfect purification of the water passing through the ground to the wells from the Merrimack River. The quality of the river water, owing chiefly to the shortage in rainfall, has also shown considerable deterioration.

There is no evidence as yet that the deterioration of the well water has reached such a point that the water is unsafe for drinking; but it is impracticable, with such a water, to determine with certainty how long, with continued deterioration, it may be used with safety. Under the circumstances, it is of the greatest importance that the efforts now being made to locate new wells in other areas shall be carried on as rapidly as practicable, and that the old wells then be examined and those furnishing inferior water discontinued, as recommended in the communication of the Board of July 7, 1910.

NOV. 29, 1911.

To the Water Board of the City of Lowell, Mass.

GENTLEMEN: — In response to your request for the opinion of the State Board of Health as to the quality of the water of certain test wells north of the Pawtucket Boulevard in the neighborhood of the lower pumping station, the Board has caused the locality to be examined and samples of the water of the test wells and of other wells in the neighborhood to be analyzed.

The results of the analyses show that the water of a part of the wells situated in the neighborhood of Riverview Avenue is considerably polluted, and this pollution is noticeable not only in the new test wells in west line No. 2, so called, and in the northwest line, but also in west line No. 1 and in line "B." An examination of the locality shows that there are two dwelling houses in the neighborhood of Riverview Avenue and Clyde Street north of the wells, the sewage from which is discharged into privies and cesspools on the premises. These receptacles are not tight, and sewage from them evidently finds its way into the soil and pollutes the ground water. Samples of water from the wells from which the domestic supply is obtained at each of these houses show that the ground water in this neighborhood is polluted, and that the pollution which affects the wells in a narrow belt of land extending apparently from the neighborhood of these houses southerly toward the Boulevard wells doubtless comes from these houses.

While in its present state the water of the wells affected by this pollution is probably safe for drinking, a different condition would be created if water should be pumped continually from the ground in the neighborhood of the test wells, and the pollution of the ground water by the dwelling houses in the neighborhood of Clyde Street might then become a serious matter.

Considering the circumstances, it is very important, in the opinion of the Board, that these houses be acquired and that all of the sewage, so far as practicable, be removed from the ground about them before water from the ground in the neighborhood of the test wells is supplied for drinking. After the discharge of sewage into the ground in this locality has been prevented, it is probable that the polluted ground water can in a short time be pumped out of the ground in this region and disposed of, and danger of injury to the water supply of the city from this sewage prevented.

All of the test wells yielded water quite freely, but the presence of hardpan found at a moderate depth, together with the distance from the river, renders it impossible to give a definite opinion as to the probable quality and quantity of the water obtainable in this locality until a test has been made by pumping continuously from wells at this place for a sufficient length of time to remove the present ground water and to produce the conditions likely to exist if the wells were used permanently.

The Board recommends that the dwelling houses be acquired as soon as practicable, and that the buildings, including all sources of possible pollution of the ground water, be removed. The next step will be to make a pumping test as suggested. The Board will assist you in further investigations if you so request by making the necessary analyses of the water and will give you further advice, if desired, after the results of the further tests are available.

LYNN.

MAY 4, 1911.

To MR. THOMAS CAMPBELL, 2d, *Commissioner of Water and Water Works of the City of Lynn.*

DEAR SIR: — The State Board of Health has considered your application of May 1, 1911, under the provisions of chapter 75, section 117, of the Revised Laws, for advice as to the methods of purifying and increasing the storage of the water supply of the city of Lynn by installing a pump at the upper end of Glen Lewis Pond to lift the water on to the watershed of Breed's Pond, by installing a pump at Montrose so that it will be practicable to take water from the Saugus River at any time, and by raising Breed's Pond dam.

The calculations of the probable yield of the watersheds of your present sources of supply, assuming that the consumption of water will be no greater than in the past year, indicate that if the dry weather of the past twenty-four months continues for twelve months longer and the present method of handling the water is continued, it will be practicable to get only about 50 days' storage, and in the spring of 1912 the storage would be exhausted; and if the same low rainfall continues there would not be sufficient water to supply the city through another summer even if Saugus River water should be pumped directly into the distributing mains.

The only practicable way to prevent this result in the present emergency is, in the opinion of the Board, to establish in the shortest possible time an ample pumping plant at Montrose to take into Hawkes Pond all of the water that may flow in the Saugus River this year, and another adequate pumping plant near the east end of the arm of Walden Pond formerly known as Glen Lewis Pond to pump the water of Walden Pond over the divide to Breed's Pond. It will then be practicable to pump all of the water in Saugus River into Hawkes Pond, to pump the water from Hawkes Pond at the present Walden Pond pumping station into Walden Pond, and to pump the water of Walden Pond from the upper end of Glen Lewis Pond into the watershed of Breed's Pond, as outlined in the plan described in your application.

In addition thereto it is necessary to enlarge the outlet of Breed's Pond down to the 30-inch main leading from Birch Pond to the pumping station. A connection with this main will require less pipe than a main directly to the pumping station and will be an advantage in that water may be run from Breed's Pond into Birch Pond in the hours when the pumps are not running.

By this plan the amount of available storage will be increased over the amount available by the present methods of pumping by the equivalent of about 1,000,000,000 gallons, and it is probable that by this method the present storage capacity will be sufficient to supply the city of Lynn from the Saugus River for several years in the future and take no water into the city that has not been in storage for as much as six months.

The raising of Breed's Pond dam, increasing the capacity of that reservoir, would lengthen somewhat the period of storage if the water were handled as now proposed, and were it practicable for the city to depend upon its ponds and the Saugus River for the future supply, no better means appears for increasing the supply up to the limit of this source; but with the increase in population of the city the supply from Saugus River will be sufficient only for a few years. The next available local source of supply is Ipswich River.

The rights which, under the provisions of chapter 508 of the Acts of the year 1901, the city has in Ipswich River and any further rights that may be acquired will necessarily limit the time of draft from that river to certain months, — in some years the time may be reduced to about two months, — and require during the limited time very heavy pumping and large storage capacity with large pipes from the pumping plant to the storage reservoir.

These conditions indicate that the large receiving reservoir for this water should be as near as practicable to Ipswich River, and be at such a height that water can be drawn therefrom by gravity in moderate quantities as required for distribution through the present reservoirs.

Futhermore, the question of the taking of water from the Ipswich River watershed in large quantities by other communities is now under consideration, and it is desirable that plans by which Lynn's rights in this watershed can be utilized should be considered.

Under the circumstances, in order to make it possible to maintain as good a supply as has been maintained during the past two years, the Board advises the immediate construction of the pumping plant at Montrose, with the necessary appurtenances and works to make it practicable to take all of the flow of the Saugus River into Hawkes Pond; the immediate installation of a pump at the upper end of Glen Lewis Pond and the necessary pipe line and appurtenances to lift the water upon the watershed of Breed's Pond, as proposed in your application; and the enlargement of the outlet of Breed's Pond, as above mentioned; and that the necessary surveys and studies be made to determine the best plan of utilizing as fully as practicable the rights of the city of Lynn in the Ipswich River, together with the necessary surveys and plans for raising the level of Breed's Pond with the dikes and other works incident thereto.

When this information is available, it will be practicable to advise you more definitely as to raising Breed's Pond.

MANSFIELD.

AUG. 3, 1911.

To the Board of Water Commissioners of the Mansfield Water Supply District.

GENTLEMEN: — The State Board of Health received from you on April 6, 1911, a petition for its consent to and approval of the purchase or taking of certain lands in the town of Mansfield for the purpose of protecting and preserving the purity of the water of the well used as the source of water supply for the Mansfield Water Supply District. Subsequently a plan and description of the lands which it is proposed to acquire were submitted.

In response to this petition the Board gave a public hearing, as required by chapter 499 of the Acts of the year 1908, as amended by chapter 135 of the Acts of the year 1911, at its office, Room 143, State House, on Thursday, July 6, 1911, notice of said hearing having been given by publication in the "Mansfield News."

After the hearing, and after causing an examination of the lands in question to be made, the Board upon consideration voted to consent to and approve of the purchase or taking by the Mansfield Water Supply District of certain lands lying in the town of Mansfield and shown upon a plan filed in this office May 26, 1911, entitled "Plan of Proposed Taking of Land for Protection of Water of Mansfield Water Supply District. Mansfield, Mass., 1911. Scale 1″ = 100′. Surveyed by Sherman & Perkins."

The lands, the taking of which is herein approved, have an aggregate area of 114.35 acres more or less, and are bounded, measured and described as follows: —

Land of Heirs of Jesse Atherton.

Beginning at a point in the Mansfield and Foxboro Town line at a corner of land of the Old Colony R. R. Co. thence running by said town line N. 75° 44′ E. 1141.75 feet to stake and stones; thence running S. 47° 16′ E. by land of grantors 431.25 feet to land of R. L. Chamberlain; thence running by the land of said Chamberlain S. 1° 35′ E. 166.75 feet to heap of stones; thence running by same land N. 85° 45′ W. 1380.00 feet to stake and stones in line of land of said railroad company; thence by said land N. 34° 45′ W. 98.00 feet to place of beginning. Containing 8⁶⁷⁄₁₀₀ acres more or less.

Land of Daniel Leonard.

Beginning at a granite bound at the southeasterly corner of the Pumping Station Lot of the Mansfield Water Supply District; thence running N. 80° 23′ E. by land of D. S. Spaulding 310± feet to center of Canoe River; thence running northerly by said center of river to corner of land of Nils R. A. Hogner, the distance in a straight line being about 210 feet; thence running westerly by said Hogner land 250± feet to said District land; thence running southerly in ditch by said land about 295 feet to place of beginning.

Containing one and one half acres, more or less.

Land of Christine A. Hogner.

Beginning at a corner of a stone wall in the southeasterly line of "Copeland Road"; thence running N. 49° 15′ E. 30.50 feet to stake by wall; thence running S. 47° 16′ E. by land of grantor 584.25 feet to stake and stones; thence running S. 1° 15′ W. by land of grantor 116.25 feet to stake and stones in line of land of David Holmes et al; thence running N. 39° 40′ W. by said Holmes land 123.50 feet to center of Canoe River; thence running southerly by said center of river to northeasterly corner of land of Nils R. A. Hogner near a "watering place"; thence running N. 86° W. by land of said Hogner 475. feet to corner of land of Sanford A. Morse; thence running N. 2° 45′ W. by land of said Morse 594± feet to a corner; thence running N. 52° E. by same land 234.30 feet to a corner; thence running N. 37° W. by same land 41. feet to place of beginning. Containing 6 acres, more or less.

Land of S. H. DiJeser and Michael Fisher.

Beginning at a point in the easterly line of the "Copeland Road" near the easterly end of Oakland Street; thence running S. 85° 03′ E. 410.18 feet by land of Mansfield Water Supply District; thence running by same land S. 23° 45′ E. 463.00 feet; thence running by same land N. 82° 40′ E. 202.00 feet to corner of land of D. S. Spaulding; thence running S. 9° 18′ E. by said Spaulding land 171.00 feet to a stone bound; thence running S. 80° 42′ W. 1103.25 feet to easterly line of said Copeland Road; thence running respectively by said easterly line N. 15° 11′ E. 527.55 feet, N. 23° 44′ E 215.10 feet and N. 29° 14′ E. 116.35 feet to place of beginning.

Containing 13.50 acres, more or less.

From the above five lots have been sold and deeds recorded prior to May first, 1911.

Lots numbered 88 and 89 to Fillippo Capone.
" " 92 and 55 " Antonio Gambali.
" " 35 on Kenny Street to Giovanni Saia.

For further description reference may be made to a plan made by Goff and Schofield, October 1910, on file with Bristol County Registry of Deeds, North District.

Land of Nils R. A. Hogner.

Beginning at the northeasterly corner of the Pumping Station Lot at the intersection of walls; thence N. 1° 45′ W. by land of S. A. Morse 147.50 feet; thence running S. 86° E. 16.50 feet to corner of land of C. A. Hogner; thence continue same course by land of said C. A. Hogner and running 475.00 feet to center of river (Canoe); thence running southerly by said center of river to a corner of land of Daniel Leonard, the distance in a straight line being about 600 feet; thence running westerly about 250 feet by land of said Leonard to a ditch in line of land of Mansfield Water Supply District; thence running northerly by said ditch about 215.00 feet to a turn in ditch; thence running northwesterly by said ditch 79.00 feet; thence running N. 10° W. 230.00 feet to place of beginning.

Containing 5¼ acres more or less.

Land of Heirs of Patrick Hearn.

Beginning at a point in the westerly line of "Copeland Road"; being a corner of W. M. Lowney land; thence running N. 79° W. 72.00 feet to a corner; thence running by land of said Lowney N. 7° W. 356.00 feet to corner of land of S. A. Morse; thence running N. 86° 30′ E. 255.00 feet to the westerly line of said Copeland Road; thence running southerly by said road 420.00 feet to place of beginning.

Containing $1\frac{34}{100}$ acres more or less.

Land of Roland L. Chamberlain.

Beginning at the northeasterly corner of land of S. R. Morse at stake and stones near the westerly side of "Copeland Road"; thence running S. 52° 45′ W. 234.75 feet by land of said Morse and within the limits of said road to stake and stones; thence running N. 83° 30′ W. by land of said Morse 1370± feet to stake in wall; thence running N. 34° 45′ W. by land of Old Colony R. R. Co. 297.00 feet to stake and stones at corner of land of heirs of Jesse Atherton; thence running S. 85° 45′ E. by said heirs' land 1380.00 feet to a heap of stones; thence running N. 1° 35′ W. 166.75 feet by same land to stake and stones; thence running by land of grantor S. 47° 16′ E. 531.00 feet to stake in wall in southeasterly line of said "Copeland Road"; thence running S. 49° 15′ W. 30.50 feet by said line to corner of land of Christine A. Hogner; thence running N. 37° W. by land of the aforesaid S. A. Morse 22.00 feet to place of beginning.

Containing $10\frac{7}{100}$ acres more or less.

Reserving, however, that portion of "Copeland Road" included in the foregoing description.

Land of Old Colony Railroad Company.

Beginning at the northwesterly corner of said premises in the Mansfield and Foxboro Town Line; thence running N. 75° 44′ E. 367.25 feet to corner of land of Atherton heirs; thence running S. 34° 45′ E. 395.00 feet by land of said Atherton and land of R. L. Chamberlain to corner of land of S. A. Morse; thence running S. 36° 15′ E. 131.00 feet to corner of land of town of Mansfield; thence running S. 77° 50′ W. by land of said town and land of W. M. Lowney 771.00 feet; thence running N. 10° 39′ E. 514.30 feet by land of grantor to place of beginning.

Containing 6$^{28}/_{100}$ acres more or less.

Land of Elizabeth M. Holmes.

Beginning at a point in the southerly line of land of David Holmes et al. being in the northerly line of a lane running to a "watering place"; thence running S. 1° 15′ W. 466.90 feet to land of Edward A. Matthews; thence running S. 84° 30′ W. 86.70 feet by land of said Matthews to centre of Canoe River; thence running northerly by said centre of river to corner of land of said heirs; thence running S. 86° E. 32.75 feet by said heirs' land to place of beginning.

Containing 1$^{05}/_{100}$ acres more or less.

Land of Sanford A. Morse.

Beginning at a point in the westerly line of the "Copeland Road" at the northeasterly corner of land of heirs of Patrick Hearn; thence running S. 86° 30′ W. 255.00 feet by said Hearn land; thence running by land of W. M. Lowney (crossing Oakland Street) N. 11° 20′ W. 410.00 feet; thence running by same land N. 80° 45′ E. 554.00 feet; thence by same land N. 33° W. 426.00 feet; thence by same land N. 87° 23′ W. 129.50 feet to stake and stones, a corner of land of town of Mansfield; thence running by said land and land of Old Colony R. R. Co. N. 36° 15′ W. 643.00 feet to stake in wall; thence running by land of R. L. Chamberlain S. 83° 30′ E. 1370.00± feet to stake and stones near said "Copeland Road"; thence running by said land N. 52° 45′ E. 234.75 feet to stake and stones; thence running (crossing said road) S. 37° E. 22.00 feet to corner of wall; thence continuing same course by land of Christine A. Hogner 41.00 feet to end of wall; thence running by same land S. 52° W. 234.30 feet; thence running by same land S. 2° 45′ E. 594.00± feet to land of Nils R. A. Hogner; thence running N. 86° W. 16.50 feet to the corner of said Hogner land; thence running S. 1° 45′ E. by said Hogner land 147.50 feet to intersections of walls at northeast corner of land of said Water District; thence running S. 78° 15′ W. 268.50 feet by said land; thence running S. 68° 30′ W. 480.00± feet; thence running southwesterly (crossing said road) 236.00± feet to place of beginning.

Containing 27 acres more or less, including portions of Oakland Street and Copeland Road. The said Copeland Road is reserved in former deeds and is called 30 feet wide. Oakland Street being 60 feet wide.

Land of Doliver S. Spaulding.

Beginning at a stone set in stones at the southeast corner of "Royal Park Plat" owned by S. H. DiJeser and Michael Fisher; thence running N. 9° 18′ W. 171.00 feet to land of the Mansfield Water Supply District; thence running N. 80° 23′ E. 546.75 feet, passing over a granite bound situate at the southeasterly corner of land of said District to stake and stones in line of land of E. A. Matthews and at a corner of land of Henry De Mey; thence running S. 9° 37′ E. 174.00 feet by land of said De Mey to a corner; thence running S. 80° 42′ W. 546.75 feet to place of beginning.

Containing $2\frac{17}{100}$ acres more or less.

Land of David Holmes et al.

Beginning at a stake in the northerly line of land of Elizabeth M. Holmes; being in the northerly line of a 'watering place'; thence running N. 1° 15′ E. by land of grantor 401.85 feet to stake and stones in line of land of Christine A. Hogner; thence running by said Hogner land N. 39° 40′ W. 123.50 feet to center of Canoe River; thence running southerly by said center to corner of land of said Hogner; thence running S. 86° E. by land of said Elizabeth M. Holmes 32.75 feet to place of beginning.

Containing $2\frac{1}{5}$ acres more or less.

Land of Town of Mansfield.

Beginning at the southwesterly corner of said parcel at an inward corner of land of Walter M. Lowney; thence running N. 15° 10′ W. by said Lowney land 458.00 feet to land of Old Colony R. R. Co.; thence running N. 77° 50′ E. 174.00 feet to corner of said Company land; thence running S. 36° 15′ E. by land of S. A. Morse 512.00 feet to land of said Lowney; thence running S. 80° 16′ W. 354.50 feet to place of beginning.

Containing $2\frac{76}{100}$ acres, more or less.

Land of Edward A. Matthews.

Beginning at a point in the southerly line of land of Elizabeth M. Holmes; thence running S. 1° 15′ W. 293.50 feet to stake and stones, a corner of land of D. S. Spaulding and land of Henry De Mey; thence running S. 80° 23′ W. by land of said Spaulding 170± feet to center of Canoe River, a corner of land of Daniel Leonard; thence running northerly by said center of river to corner of land of Elizabeth M. Holmes; thence running N. 84° 30′ E. 86.70 feet by said Holmes land to place of beginning.

Containing 1 acre more or less.

Land of Walter M. Lowney.

Beginning at a point in the northerly line of Oakland Street; said point being 13.02 feet N. 10° 39′ E. of a stone bound situate at an angle in and over the pipe line of said Mansfield Water Supply District; thence running N. 10° 39′ E. 694.68 feet to land of the Old Colony R. R. Co.; thence running by said Company land N. 77° 50′ E. 597.00 feet to corner of land of Town of Mansfield; thence running S. 15° 10′ E. by land of said town 458.00 feet; thence running by same N. 80° 16′ E. 354.50 feet to stake and stones; thence running S. 87° 23′ E. 129.50 feet by land of Sanford A. Morse to corner; thence running by same land S. 33° E. 426.00 feet; thence running S. 80° 45′ W. 554.00 feet by same land; thence running by same land S. 11° 20′ E. 160.00± feet to said Oakland Street; thence running by land of said street N. 71° 10′ W. 389.40 feet to an angle in said street; thence running by line of said street N. 86° 37′ W. 653.00 feet to place of beginning.

Containing 19 acres more or less.

Also another lot.

Beginning at a point in the southerly line of Oakland Street, said point being 92.00 feet S. 55° 29′ E. from a stone bound situate at an angle in and over the pipe line of said Mansfield Water Supply District; thence running S. 55° 29′ E. by land of grantor 1261.50 feet to corner of land of heirs of Patrick Hearn; thence running N. 7° W. by said Hearn land 356.00 feet to corner of land of S. A. Morse; thence running by said Morse land N. 11° 20′ W. 190.00± feet to line of said street; thence running N. 71° 10′ W. 414.00± feet to angle in said street; thence running N. 86° 37′ W. 573.00± feet to place of beginning.

Containing 6 56/100 acres, more or less.

MARBLEHEAD.

Nov. 2, 1911.

To the Board of Water Commissioners of the Town of Marblehead.

GENTLEMEN: — The State Board of Health received from you on Aug. 29, 1911, the following communication relative to enlarging and improving the water supply of the town of Marblehead: —

The limit of the capacity of the wells from which the water supply of Marblehead is drawn has been reached, and it is necessary to seek an additional supply without delay. In 1908 the matter of enlarging and improving the water supply of the town was investigated by William S. Johnson, civil engineer, and as a result of these investigations it was recommended that filtration works be constructed for the purification of the water from the present sources and that water for an additional supply be taken from wells to be driven in Thompson's Meadow, about a mile from the pumping station.

On May 7, 1908, we received a communication from you, advising that this plan appeared to be the best practical method of enlarging and improving the supply, and the only practical plan by which an independent supply of good water could be obtained at a reasonable expense. Since that time the filtration plant has been installed and has operated satisfactorily, but nothing has been done toward getting an additional supply from Thompson's Meadow. During the past dry summers well No. 2, the principal source of supply, has been drawn to a very low level and, although there has been a material reduction in the consumption of water, it is evident that the limit of capacity of the wells has been reached.

The brook which flows through Thompson's Meadow has a watershed of more than one half of a square mile, and the flow of the brook is well maintained in a dry season. The water is much softer than the water drawn from the ground in the meadow, and the levels are such that it can be conveyed by gravity to the filter beds near the pumping station. If the quality of the water after filtration through the present filter plant would be satisfactory for domestic purposes, it would be possible to secure during seasons when there is a considerable flow in the brook a much softer water than could be obtained either from our present supply or from Thompson's Meadow, and the water could be obtained without pumping and at a comparatively small expense. If it were possible to use this supply during the winter and spring months, the old wells would have an opportunity to recover to such an extent that a large supply of good water could be obtained from them during the summer months when the draft is greatest.

The plan which we would submit for your consideration and advice is to construct a small intake basin at some point on the brook and convey the water from this intake to the present filter plant. At the same time wells could be driven in Thompson's Meadow as proposed in 1908, and a small pumping plant would be installed so that water might be pumped from the ground into this pipe and conveyed to the filters whenever necessary or desirable.

We would respectfully ask your advice as to the feasibility of the plan outlined above, and, if the use of water from the brook is advisable, we would like assistance in determining the best point from which to take the water. We also desire advice as to the area of land which it is desirable to acquire in order to protect the purity of the water so that after filtration it will be absolutely safe.

Our engineer will furnish you with data in regard to our present wells and also in regard to the proposed plans.

The Board has caused the present and proposed sources of supply to be examined by one of its engineers and has considered the information presented. The quantity of water used from the present sources of supply is already equal to, if not in excess of, their capacity in dry periods, and an additional supply is evidently required.

The watershed of the brook flowing through Thompson's Meadow above the lower of the proposed points of taking, though lying between the cities of Salem and Lynn and within a short distance of either city, is comparatively sparsely populated. There are, nevertheless, a number of important sources of pollution within the watershed, but the examination does not show that there is any very material difference in the quality of the water at the two points of taking suggested.

If water were taken from the brook flowing through Thompson's Meadow at the point indicated above the meadow, the quantity obtainable would not be sufficient to add very materially to the water supply of the town in a dry period, unless a storage reservoir of considerable size should be constructed. If the water of the brook should be taken at the lower of the two points suggested, near the outlet of Thompson's Meadow, a much larger supply could be obtained than at the upper point, the cost would be less and the quality of the water not materially different.

Judging from the available analyses, the water of the stream flowing through Thompson's Meadow is very variable in quality. It is frequently very highly colored, and the quantity of organic matter present at times is large. The filters which it is proposed to use for the purification of this water were built only for the removal of iron from the water of well No. 2. They could probably be adapted for the filtration of the brook water without serious difficulty, and their area is such that under efficient management they could probably be so operated as to effect a satisfactory purification of the water of this brook. It would be practicable, while the quantity of water used remains about as at present, to obtain nearly always an adequate supply of water from the brook during the winter and early spring, which will be much softer than that now supplied from well No. 2. The water would be colored considerably at times with vegetable matter and there would be considerable variation in the hardness of the water supplied to consumers. If efficiently filtered, however, the brook water is likely, in the opinion of the Board, to be on the whole more acceptable to consumers than the water of the present sources of supply.

Regarding the plan of taking water from the ground in Thompson's Meadow, no further investigations appear to have been made since you were advised as to taking water from that source in 1908. Water was obtained in considerable quantity for several years from a point near the southerly end of the meadow and used for the supply of a portion of the town of Swampscott, and later tests in the northerly part of the meadow indicate that water can be obtained freely from the ground in that locality. These tests indicate that a very considerable addition to your present sources can be obtained from the ground in Thompson's Meadow, and the results of numerous analyses of samples of water from wells in that locality show that its quality is likely to differ but little from the quality of the filtered water supplied to the town from your present sources.

MIDDLEBOROUGH.

JUNE 8, 1911.

To the Board of Selectmen, Middleborough, Mass.

GENTLEMEN: — In response to your petition the Board, after a hearing, has decided to make to the city of Taunton these recommendations as to boating, fishing and ice cutting on Assawompsett Pond.

That no permits be granted for boating, fishing or ice cutting on that portion of Assawompsett Pond which lies within one-fourth mile of the intake of the Taunton water works at Assawompsett Pond, except that boatmen be allowed to cross these waters in passing from one part of the pond to another;

That no permits be required hereafter for boating, fishing or ice cutting on the portion of the pond east of a line drawn from the Nemasket River to a point one-fourth mile west of the mouth of Tamett Brook.

DEC. 20, 1911.

To the Board of Water Commissioners of the Middleborough Fire District.

GENTLEMEN: — The State Board of Health received from you on Dec. 13, 1911, an application for advice relative to the improvement of the water supply of the town of Middleborough, in which three plans are suggested: one, the filtration of the water of the present well for the removal of iron; two, the sinking of tubular wells in the valley of the Nemasket River about a quarter of a mile above the pumping station, to be used in place of the water of the present well; and three, the sinking of deep tubular wells in the neighborhood of the present pumping station. You have also submitted the results of tests made for the purpose of obtaining a ground-water supply in the neighborhood of the pumping station and sketches of works proposed for removing the iron from the water of your present well.

The Board has caused the locality to be examined by its engineer and has considered the plans presented and the character of the water from your present well, as shown by numerous analyses covering a period of many years.

The results of these analyses show that the quantity of iron in the water has been increasing rapidly for several years and that the amount has become so great as to make the water objectionable for many domestic uses. Experience in the treatment of water containing an excessive quantity of iron has shown that, while in some cases the removal of an excess of iron is very difficult, in others it is removed readily by thorough aeration and subsequent filtration through sand. The tests which you have made and the results of analyses of the water indicate that in its present condition the excess of iron can be removed from the water supply of Middleborough without very serious difficulty.

The quantity of water supplied from the well during recent very dry years has been ample for all the requirements of the town, and if the policy of metering the services is extended until practically all services are supplied through meters, it is probable that the present well will furnish a sufficient quantity of water for several years in the future.

The tests made with a view to obtaining water from driven wells in the neighborhood of the pumping station have shown that in the immediate neighborhood of the pumping station the conditions are not favorable for obtaining water freely from the ground; but at a point on the south side of the river, about one-quarter of a mile above the pumping station, the wells penetrated a porous stratum of soil at a depth of approximately 30 feet, from which water could be drawn very freely, and analyses of samples of the water from these wells indicate that it would be of good quality for domestic purposes. The conditions affecting the character of the water might, however, be changed considerably if the quantity required for the supply of the town should be drawn continually from the ground at this place, and in order to determine the probable quality of the water, as well as the probable quantity that might be obtained at the locality indicated, a further test is necessary. This test could best be made by sinking a number of wells, — probably ten or twelve, — connecting them with a power pump and pumping from them continuously for a period of two weeks or more, at a rate of as much as half a million gallons per day, observing by means of other wells in the region the fluctuation of the ground water in the neighborhood, and testing at the same time the character of the water by means of frequent analyses, to determine the probability of any material change in its quality with continued use.

Such a test would probably cost from $1,000 to $1,500 and possibly more, but if the results were satisfactory and it was decided to take water from the ground in that locality, the test wells might form a part of the permanent works, so that the net cost to the town in that case would probably be about one-third of the amount expended for the test.

It is probable that in case the test should show that a sufficient supply of good water could be obtained from the tubular wells, as proposed, the cost of supplying the town with water by this plan would be somewhat less than the cost of filtering the water of the present source, though the difference in cost between the two plans would probably not be great. It is not probable that there would be any very material difference in the quality of the water obtainable under these plans, though the water of the tubular wells a quarter of a mile above the pumping station would, so far as can be judged from the very limited information thus far available, probably be somewhat softer and to that extent more desirable than the water of the present source after filtration.

Regarding the plan of sinking deep tubular wells, by which are meant, presumably, wells 150 feet or more in depth, in the neighborhood of the pumping station or elsewhere, it is impossible to give you definite advice as to the probable results. Such wells have been tried in many places in Massachusetts, but in the majority of cases the quantity of water obtained has been quite limited and the quality is frequently undesirable for domestic purposes. Judging from the experience elsewhere it is unlikely that an adequate supply of good water can be obtained by means of deep wells, as proposed.

Should you decide to make further tests to determine the probable quantity and character of the water obtainable from the ground in the valley of the river above the pumping station, the Board will, upon request, assist you by making the necessary analyses of water and will then advise you, if you desire, as to the probable quantity and character of the water obtainable there.

In case you decide to filter the water of the present well, it will be very desirable before beginning the construction of works to make more thorough tests, in order to make certain that the water can be efficiently purified and to determine more definitely the most favorable arrangement of works for this purpose. The Board will, upon request, advise you as to conducting these tests and as to final plans of purification works.

MILTON.

MAY 4, 1911.

To the Board of Water Commissioners of the Town of Milton, Mass.

GENTLEMEN: — In response to your request for an examination of the water supplied through faucets in Milton and advice as to the quantity of lead present therein, the Board has caused samples of water to be collected from several faucets in different parts of the town on two different dates and the quantity of lead therein to be determined by analysis.

The results show that the quantity present in each of the faucets examined averaged much less than the minimum amount which has been known to cause lead poisoning. Samples collected from the same faucets early in the morning after the water had been standing over night and before any had been drawn showed in only one case a notably higher quantity of lead, and this amount was in the second sample examined and was but little more than the minimum amount known to have caused lead poisoning.

The results do not indicate that the action of the water on lead service pipes in Milton is sufficient to cause lead poisoning, but where such pipes are in use it is desirable that enough water be allowed to run from the faucet to empty the service pipe before the water is used for drinking.

MONSON (STATE HOSPITAL).

JAN. 5, 1911.

TO EVERETT FLOOD, M.D., *Superintendent of the Monson State Hospital, Palmer, Mass.*

DEAR SIR: — The State Board of Health has considered your communication of Dec. 21, 1910, with reference to investigations which you propose to make with a view to obtaining an emergency water supply for the hospital by sinking wells between the brook flowing through the grounds of the institution and the gravel bank at the foot of the slope formerly used as a sewage irrigation area, and has caused the locality to be examined by one of its engineers.

Judging from surface indications in the neighborhood of the place where it is proposed to make the tests, the soil is probably coarse and porous, and the conditions appear to be favorable for obtaining water from the ground by means of wells in this locality. Regarding the probable quality of the water obtainable from the ground at this location, the circumstances are not favorable. Sewage has been discharged upon the ground at several points on the higher lands adjacent to the low ground in which it is proposed to locate the wells, and it is likely that the ground water at the locality indicated would show marked evidence of previous sewage contamination.

Considering the conditions it does not seem to the Board likely that water of good quality for domestic purposes can be obtained from the ground at the locality indicated.

The only other locality within the lands owned by the hospital where the conditions appear to be favorable for obtaining water freely from the ground, at a point sufficiently distant from possible sources of pollution to make it likely that a desirable ground-water supply could be obtained, is in the low ground just west of the New London Northern Railroad and north of the point where it is crossed by the highway which passes the hospital buildings; but tests made at this point in 1896 indicated that the ground water was likely to be affected by an excessive quantity of iron, which would make it objectionable for domestic use.

It is possible that an adequate supply of good water might be obtained for the institution near the foot of the slope west of the New London Northern Railroad and south of the highway, from one-quarter to one-half a mile south of the location of the test wells sunk in 1896, but this locality is beyond the limits of the land owned by the hospital. If it is likely that land can be obtained in that region at a reasonable cost, it might be advisable to make tests there with a view to obtaining water for the supply of the institution. This location appears to be the most favorable place in which to make tests for a ground-water supply in the immediate neighborhood of the hospital.

MONTEREY.

MAY 4, 1911.

To Messrs. ARTHUR M. MINER, O. C. BIDWELL, JOHN VAN BURK and JASPER H. BILLS, *Monterey, Mass.*

GENTLEMEN: — The State Board of Health received from you on April 12, 1911, an application for advice as to a proposed system of water supply for the village of Monterey, which you describe as follows: —

> The proposed source of supply is a spring of water on the mountain side on land of Philando C. Harmon in the extreme southerly part of the town . . .
>
> The spring is located in a territory of woodland about 1,470 feet above sea level — 170 feet above the post-office, lowest level in center of the village of Monterey — and about 100 feet above any of the higher elevations on which there will be water takers.
>
> This elevation, it is believed, will make possible a supply entirely by gravity.
>
> The length of the main pipe line, as surveyed, the approximate location of which is shown on plan, is 13,000 feet.

The plan is accompanied by a sketch showing the location of the spring from which it is proposed to take the supply and the line of the main pipe leading to the village. It is understood that the system is to be constructed of small pipes, with a view to supplying water for domestic purposes only to the inhabitants of the main village and its vicinity, to the dwelling houses along the pipe line and probably to the summer cottages in the neighborhood of Lake Garfield.

The Board has caused the locality to be examined by one of its engineers and a sample of water from the spring to be analyzed. The region about the spring is uninhabited and the results of the analysis show that the water is of excellent quality for the purposes of a public water supply. The quantity of water flowing from the spring at the present time is apparently between 30,000 and 40,000 gallons per day, a quantity which is probably considerably greater than would be required by the population which it is proposed to supply; but, while the flow of the spring is said to be well maintained in the summer season, it is not improbable that in very dry years the flow will be considerably less than was found at the time of the recent examination. It is likely, however, that if a deep basin should be constructed at the location of the spring, a sufficient quantity of water could be obtained for the requirements of the village with reasonable use unless the population becomes considerably greater than at the present time.

It is understood that you do not propose to build works during the present year, and the Board recommends that a basin be excavated at the site of the spring and careful measurements of the flow kept during the remainder of the present year to determine more definitely its probable yield. When the results of the observations suggested are available, the Board can advise you more definitely as to the practicability of obtaining an adequate supply of water for Monterey from this source.

NANTUCKET.

MARCH 2, 1911.

To the Nantucket Water Company, MR. WILLIAM F. CODD, *Treasurer.*

GENTLEMEN: — The State Board of Health received from you early last year a request for advice as to enlarging and improving the water supply of Nantucket, and subsequently further information was submitted from time to time, showing the results of tests in various places with a view to securing a supply of water from the ground at some point in the region about Wannacomet Pond, from which your present supply is taken.

It appears that the water of Wannacomet Pond has been drawn to so low a level that it has been deemed necessary to restrict the use of water in the town to avoid danger of shortage, and it is evident that an additional supply must be provided to meet the requirements of the town, which have been gradually increasing for several years. The water of Wannacomet Pond, moreover, though it is usually of good quality for the purposes of a domestic water supply, is affected at times, especially during the summer and early fall, in every two or three years, by the presence of excessive numbers of micro-organisms, which makes it very objectionable for drinking and other domestic purposes, and in securing an additional supply it is desired to obtain a sufficient quantity of water to make it practicable to avoid the use of water taken directly from the pond at times when the presence of the large numbers of micro-organisms makes its quality objectionable.

The tests thus far made have been confined to two localities, — one near the southerly end of Wannacomet Pond, and the other about 450 feet west of Maxcy's Pond and 1,500 feet southwest of the present pumping station at Wannacomet Pond. The tests at the point west of Maxcy's Pond show that the soil in that location consists of very fine sand for the first 9 or 10 feet at the surface, beneath which is a stratum of coarse sand and fine gravel about 4 feet in thickness, which is underlaid with very fine sand, extending apparently to a great depth.

Late in the summer of 1909 a pumping test was made by pumping from a well sunk in the coarse sand and gravel stratum in this locality, and analyses of samples of water collected and sent in by you during the test indicated that its quality was likely to be excellent for water supply purposes, but the quantity of water obtained from this test well was less than a tenth the quantity required for the supply of the town in the summer months.

Subsequently tests were made to determine the practicability of a proposed plan of obtaining water from the ground near the southerly end of Wannacomet Pond by means of tubular wells. The results of these tests indicated that water could be obtained from the ground in this locality with considerable freedom, but, while the water obtained from the ground on the easterly side of the valley was of good quality for water supply purposes, the water on the westerly side was affected by the presence of an excessive quantity of organic matter and iron, which would make it very objectionable for domestic purposes.

Considering the results of these tests, it does not seem to the Board probable that a sufficient quantity of good water for the requirements of the town can be obtained from the ground at either of the points where the recent tests were made.

Analyses have also been made of the water of the two ponds known as Maxcy's Pond and the Head of Hummock Pond, the results showing that the water of each of these ponds, though not very highly colored, contains large quantities of organic matter, consisting largely of microscopic organisms, and that neither source is likely to furnish water equal in quality to that now obtained from Wannacomet Pond.

An ample quantity of water for the requirements of Nantucket can be obtained by supplementing the yield of Wannacomet Pond with water pumped from either Maxcy's Pond or the Head of Hummock Pond, and it is probable, in the opinion of the Board, that the mingled waters of these ponds could be efficiently purified by suitable filtration and made satisfactory for domestic purposes at all times; but the cost of constructing and operating the necessary purification works would be considerable, and a ground-water supply, if a suitable one can be obtained, is likely to be less expensive and more satisfactory than a supply taken from the available surface-water sources.

It is impracticable for the Board with its present information to advise you definitely as to the most favorable places in which to make tests for a ground-water supply. The test near Maxcy's Pond was very favorable, so far as concerns the quality of the water, and it is possible that better results, so far as the quantity is concerned, could be obtained from wells located nearer this pond, but it is not advisable to locate test wells at distances of less than 75 feet from the pond.

The conditions about the Head of Hummock Pond appear to be such as to warrant careful tests in that locality, though this pond is located at a considerable distance from your pumping stations, and it is possible also that favorable conditions may be found a quarter of a mile or more south of Copaum Pond. The Board will assist you in further investigations, as heretofore, by making the necessary analyses of water, and upon application will give you further advice when the results of further tests are available.

NEW BEDFORD (TUBERCULOSIS SANATORIUM).

JUNE 12, 1911.

To Miss MARY C. MCHAFFEY, *Superintendent New Bedford Tuberculosis Sanatorium, New Bedford, Mass.*

DEAR MADAM: — In response to your request for an examination of the water of a well used as a source of water supply at the New Bedford Tuberculosis Sanatorium, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

It appears that the source of supply is a tubular well 6 inches in diameter and said to be 197 feet in depth, located upon the hospital grounds close to the buildings. The results of the analysis of the water show that at the present time it is of good quality and safe for drinking. It is very important to guard against danger of the pollution of the water from the neighboring buildings of the hospital, which are situated very close to the well. It will probably be safer, if the water supply system of the city of New Bedford is extended to this region, to use the New Bedford water supply for drinking purposes as soon as it is available.

NEW BEDFORD (BEACON MANUFACTURING COMPANY).

JUNE 12, 1911.

To Dr. A. S. MACKNIGHT, *State Inspector of Health, District No. 1, Fall River, Mass.*

DEAR SIR: — In response to your request for an examination of the water used at the Beacon Manufacturing Company on Purchase Street in the northerly part of New Bedford and advice both as to the quality of the water used for drinking and for humidifying, the Board has caused the locality to be examined and samples of the waters indicated to be analyzed.

It appears from the information furnished the Board that the water used for drinking is obtained from the New Bedford city mains and is distributed to the various parts of the mill in barrels in which ice and a preparation of oatmeal are placed in the summer time. It is understood that it is desired to learn whether the water as supplied from these various barrels is suitable for drinking or whether by improper cleaning the water is rendered unsafe. An analysis of a sample of water from one of these barrels shows that it has an unpleasant odor and contains an enormous quantity of organic matter and bacteria, the former probably being due largely to the oatmeal, while the latter may be due either to the oatmeal, the ice or to neglect to properly clean the barrels.

The best plan of supplying water in this mill will be to use the water of the New Bedford water works cooled with ice applied outside of the tank in which the water is stored, and if it is desired to use oatmeal in the water it can be added in pitchers or pails for the purpose and danger of the pollution of the tanks avoided.

The water used in the humidifiers, while containing a large quantity of organic matter taken up evidently from the bottom of the pond in which it is stored and from the watershed, which would render it objectionable for drinking, does not appear to be seriously polluted at the present time and is safe for use in the humidifiers. It is important, if the use of this water is continued for this purpose, that the watershed be examined from time to time to determine whether the reservoir or its tributaries are polluted at any point by sewage.

NORTH ATTLEBOROUGH.

MAY 27, 1911.

To the Board of Water Commissioners of the Town of North Attleborough.

GENTLEMEN: — In response to a request for advice as to a proposed plan of constructing a concrete grandstand upon the athletic field known as Columbia Field, north of the water works pumping station, with reference to the possible effect upon the water supply of the town, the Board has caused the locality to be examined by one of its engineers.

It appears that the field on which the grandstand is to be constructed has been maintained as an athletic field for many years, being used chiefly for baseball and football games, and the proposed new grandstand, which will be about 300 feet north of the well from which the water supply of the town is taken, is to replace a wooden structure which has been in use for several years. The Board is informed that the new grandstand is to be enclosed but that no sanitary arrangements are to be provided on the field and that the conditions will differ in no way from those which have existed there for several years. Under these conditions it does not appear to the Board that the continued use of these grounds for the purpose and to the extent to which they have been used in the past will cause any material injury to the quality of the water of the well near the pumping station.

NORTON.

Nov. 1, 1911.

To the Norton Water Company, Norton, Mass.

GENTLEMEN: — The State Board of Health has considered your application for its consent, under the provisions of chapter 466 of the Acts of the year 1910, to the taking of water for the supply of the inhabitants of the town of Norton from the ground near Lincoln Springs, so called, in the valley of a tributary of the Three Mile River about two miles southeast of the village of Norton and half a mile northwest of Crane's Station on the New York, New Haven & Hartford Railroad, and has caused the locality to be examined by its engineer and samples of the water from test wells at the location indicated to be analyzed.

The results of the analyses show that the water of test wells located along the southerly side of the valley of the small brook below Lincoln Springs between the highway and the Three Mile River is of good quality for domestic purposes, and the quantity of water pumped from wells in this locality during a pumping test between Sept. 22 and Oct. 11, 1911, indicates that an adequate supply of water for the requirements of Norton can be obtained from the ground in this locality.

In view of the results of the investigation the Board, acting under the provisions of chapter 466 of the Acts of the year 1910, consents to the taking of water by the Norton Water Company from the valley of the small tributary of the Three Mile River below the Lincoln Springs, as described above, and the Board approves the location of the wells situated close to the bluff on the southeasterly side of the brook from which water was drawn during the latter part of the pumping test.

It is important, if additional wells shall be put in, in connection with the final works, that they shall be located as near as practicable to the bluff on the southeasterly side of the valley, since the soil in the central part of the valley near the brook appears to contain very fine sand or clay which might render the water turbid.

It is understood that a considerable area of land will be secured in the neighborhood of the wells for the purpose of protecting the quality of the water, and it is desirable that the lands include areas about the small pond above the highway including the Lincoln Springs, so called, where an additional supply may be obtained in the future if necessary.

NORWOOD.

JULY 6, 1911.

To the Board of Water Commissioners, Norwood, Mass., Mr. JOHN F. CALLAHAN, *Chairman.*

GENTLEMEN: — The State Board of Health has considered your application of June 12, 1911, for advice as to a proposed additional water supply for the town of Norwood, to be taken from tubular wells near Purgatory Brook in the northeasterly part of the town, and has examined the results of a pumping test made by pumping from eight tubular wells in this locality from June 2 to June 11.

An earlier investigation in this region, made in 1905, indicated that a large quantity of water could probably be obtained from the ground in this valley by means of tubular wells, but there appeared to be danger that the ground water at the location then tested would be affected by the presence of an excessive quantity of iron, and you were advised to secure, if possible, a location on the easterly side of Purgatory Brook, where the conditions appear to be more favorable for obtaining water free from an excess of iron.

It appears that it has been found impracticable up to the present time to make tests in the locality indicated, but in view of the urgent necessity for an additional water supply, it is deemed desirable to use water from the locality northwest of Purgatory Brook, if an adequate supply of suitable water can be obtained there.

During the recent pumping test water was pumped practically continuously from a group of eight wells located in the upland from 200 to 450 feet northeast of the wells tested in 1905, and samples of water were collected at frequent intervals during the test and sent in to the laboratory of the Board for analysis. It is evident from the analyses that the ground water at the locality now selected has at some time been polluted, probably by the cultivation of the ground in the neighborhood of the wells and in part also from groups of farm buildings located at a considerable distance from the wells; but the analyses show that the water has been thoroughly purified in its passage through the ground before entering the wells and is at present of good quality for domestic purposes, the quantity of iron present being insignificant.

The quantity of water pumped from the wells during the test was not great, but the indications furnished by this and previous tests are favorable for obtaining an adequate quantity of water in this locality for the present requirements of the town when used in connection with your present source.

Considering the circumstances, the plan of taking water from the ground in this locality appears to the Board to be the best available method of increasing your water supply in the present emergency. It is important for the town to control the lands in the immediate neighborhood of the wells and prevent further cultivation and use of the soil there, and it will also be desirable to acquire control of the group of buildings nearest to the wells, which are situated at a distance of about 800 feet, in order to prevent danger of pollution of the ground water therefrom. It is very desirable to plan the works, so far as practicable, so that at some future time they may be extended to the region across Purgatory Brook, where it is probable that water of better quality can be obtained.

There is no reason to doubt that if water from the wells near Purgatory Brook should be stored in an open reservoir it would deteriorate rapidly and become objectionable, on account of growths of organisms and the tastes and odors resulting therefrom. It is understood, however, that danger from this cause will be obviated by the construction and use of a covered tank, keeping the present open reservoir for use in emergencies. It is likely, however, that while the present source is in use, pumping at the two stations can be so arranged, for some time at least, that there will be no danger that any of the well water will reach the open reservoir.

SEPT. 7, 1911.

To the Board of Water Commissioners, Norwood, Mass.

GENTLEMEN: — The State Board of Health received from you on Aug. 22, 1911, an application relative to the use as a temporary water supply for the town of certain wells situated on the edge of Purgatory Swamp, about 600 feet northeast of Pleasant Street in Norwood, and has caused the locality to be examined by its engineer and considered the results of examinations of the water of these wells made in previous years.

It appears that Buckmaster Pond, the present source of water supply, has been drawn to a very low level and that it is necessary to make provision as soon as practicable for an additional supply to be used to meet the present emergency. A test of the wells near Pleasant Street, made several years ago, showed that, while the water entering these wells had at some time been polluted, at the time of this test it was being well purified in its passage through the ground before entering the wells, and at that time the water was safe for drinking.

The conditions affecting these wells do not appear to have changed since the test mentioned was made, and, while the quality of the water may deteriorate with continued use, it is unlikely that it will become objectionable if used only in quantities sufficient to meet the present requirements and if a permanent supply from some suitable source is provided in the near future. There appears to be no other source readily available from which the town can obtain a better water supply to meet the present emergency, and, considering the circumstances, the Board approves the use of water from these wells, under the provisions of chapter 25, section 35, of the Revised Laws. The Board recommends that while water from this source is used it be analyzed from time to time, in order that any serious deterioration may be detected. It is also desirable that after the pump is set up and connected with the wells a sample of the water be analyzed before it is turned on for the supply of the town. The Board will, upon request, make the analyses suggested and supply you with the results.

PALMER (TOWN FARM).

APRIL 6, 1911.

To the Board of Health, Palmer, Mass.

GENTLEMEN: — In accordance with your request for an examination of the water of certain springs from which it is proposed to take water for the supply of the town farm in Palmer, the Board has caused the springs and their surroundings to be examined and a sample of water from one of the springs to be analyzed.

The springs are located about a quarter of a mile north of Calkins, or Thompson's, Pond and three-quarters of a mile southeast of the town farm, in an uninhabited region. The results of the analysis show that the water is of very good quality for domestic purposes, and it is likely that if the works for collecting the water are constructed at a sufficiently low level an ample quantity of water for the requirements of the town farm can be obtained from these springs.

In the opinion of the Board the proposed source is a suitable one for the water supply of the town farm.

PEABODY.

Nov. 11, 1911.

To the Commission of Public Works, Peabody, Mass.

GENTLEMEN: — The State Board of Health received from you on Oct. 30, 1911, a communication stating that an appropriation has been made by the town of Peabody to be expended by the commission of public works, to investigate a possible ground-water supply within the limits of the town, and that "an inspection of the United States topographical sheets covering this area shows three watersheds within the town of a size to warrant the commission attempting to develop a supply sufficient to overcome our deficiency which at present is threatening the town with a water famine." Concerning these areas you present the following statement: —

> The Humphrey's Brook area, one of the three aforesaid sheds, was not taken into consideration as the citizens had voted to hold this proposition, which would necessitate the expenditure of quite a large sum of money, in abeyance until all other possible sources had been investigated. This limited us to the two valleys running westerly from the center of the town, one in the vicinity of Cedar Pond and the other along Proctor's Brook.
>
> Because of the fact that the town already has a 24-inch gravity main extending from Suntaug Lake through the Cedar Pond area it was decided to test this area first as direct connection could be made with this main obviating the necessity of any expenditure for a discharge main. . . .

You further state that since September 25 about 45 wells have been driven in the valley of Goldthwaite Brook, and you request the advice of the Board as to the use of these wells as a source of additional water supply for the town.

In response to this application the Board has caused the locality to be examined by its engineer and samples of water from several of the test wells, sent in by you, to be analyzed, and has considered the results of the investigations thus far made. The tests have covered in general the territory in the valley of the brook between the poor farm and Cedar Pond, and the results show the presence in this valley of a considerable depth of peaty soil, underlaid by fine sand, beneath which there is a deep layer of very porous gravel from which water can be drawn with great freedom.

The water of most of the wells, so far as can be judged from the preliminary tests, appears to be of good quality for domestic purposes. The water of a few of the wells, especially of Nos. 14, 17 and 25, located along the northwesterly side of the main group of wells, contains a larger quantity of free ammonia and iron than the others thus far examined, and it may be found necessary or desirable after a further test to eliminate some of the wells in that neighborhood, in order to avoid drawing water containing an excessive quantity of iron. Well No. 5, located beyond the easterly limits of the main group, appears to be similarly affected. The region about the wells is sparsely populated, and by eliminating any wells which furnish water containing an excessive quantity of iron, it is likely that water of good quality for domestic purposes can be obtained in this valley.

Regarding the quantity of water that can be drawn from the wells, it is impossible to give a very close estimate from the tests thus far made, but judging from the depth and extent of the gravel stratum penetrated by the wells, it seems probable that a quantity of water which will increase materially the supply available for the use of the town in the present emergency can be drawn from the storage in the ground in this valley.

In the opinion of the Board, the proposed plan of taking water from the ground about Goldthwaite Brook above the poor farm, to meet the present emergency, is a reasonable one to adopt under the circumstances, and the Board recommends that pumps be installed and water drawn from these wells at as great a rate as practicable during the coming winter and spring. When the necessary works have been installed, the quality of the water should be tested before delivering it into the Suntaug Lake pipe line, and the Board will, upon request, make the necessary tests of the water and give you further advice as to its use for the water supply of the town.

ROCKLAND. SEE ABINGTON.

SALEM.

APRIL 6, 1911.

To the Salem Water Board, MR. E. HOWARD PERLEY, *President.*

GENTLEMEN: — In response to your request for an examination of the water of Miles River at the point where it crosses the pipe-line leading from Longham Reservoir to Wenham Lake and advice as to the use of this stream as an emergency source of water supply, by diverting the water temporarily into Wenham Lake under the provisions of chapter 25, section 35, of the Revised Laws, the Board has caused the brook and its watershed to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water contains less organic matter and has much less color than that of Longham Reservoir, now used as a source of supplementary supply.

The results of the examination of the locality show that the watershed contains several dwelling houses and camps or cottages for temporary use, most of which are remote from the stream or its tributaries and so situated that drainage from them is unlikely to affect seriously the quality of the water.

The groups of buildings from which danger of pollution is likely to be most serious are located in the lower part of the watershed, and unless pollution from these places can be prevented by the enforcement of sanitary rules and regulations it will be practicable, by extending the intakes up to the outlet of Norwood's Pond, to avoid the use of water from the portions of the watershed in which these buildings are situated. It is likely, however, that adequate protection can be secured by the enforcement of suitable sanitary regulations during the time that this water is in use, and the Board recommends that before the water is used the possible sources of pollution at the various buildings be carefully inspected and sanitary rules and regulations established.

The use of this source will not add very materially to the yield of Wenham Lake, but it is desirable to increase the quantity of water in the lake as much as practicable, and, in the opinion of the Board, the proposed source is a proper one from which to divert water into Wenham Lake in the present emergency.

OCT. 5, 1911.

To the Salem Water Board, Salem, Mass., MR. E. HOWARD PERLEY, *President.*

GENTLEMEN: — The State Board of Health has considered your application relative to taking an additional water supply for Salem and Beverly from Beck's Pond and Chebacco Lake for temporary use under the provisions of section 35 of chapter 25 of the Revised Laws, and has caused the proposed sources of supply to be examined and samples of their waters to be analyzed.

The results of the examination show that during most of the year there are very few sources of pollution on the watersheds of these ponds, and that by the enforcement of suitable sanitary rules water which may safely be used for domestic purposes can be obtained from these sources. The Board, acting under the provisions of the law above mentioned, approves the use of these ponds as a proper source of water supply for Salem and Beverly in the present emergency.

In the opinion of the Board, the quantity of water remaining in Wenham Lake at the present time, together with the water that can be expected to flow into the lake from its own watershed and that of Longham Reservoir, will be sufficient to provide all of the water required for the uses of Salem and Beverly for several months. If in the early spring of 1912 the lake appears unlikely to fill, there will still be ample time to draw a sufficient quantity of water from Beck's Pond and Chebacco Lake to provide for any probable emergency during that year. It is desirable, however, to provide the necessary means for taking water from Beck's Pond and Chebacco Lake in season for use in case of need early in the spring of 1912.

SHELBURNE FALLS (FIRE DISTRICT).

AUG. 10, 1911.

To the Board of Water Commissioners of the Shelburne Falls Fire District.

GENTLEMEN: — The State Board of Health received from you on July 29, 1911, through your engineer, plans of a proposed system of water supply for the Shelburne Falls Fire District, to be taken from Fox Brook in Shelburne and Colrain. The plans provide for taking water from a small intake reservoir to be located in the bed of the brook about 2,000 feet from its mouth, and supplying it by gravity to the village. The plans also provide for the construction of a storage reservoir about a quarter of a mile above the intake reservoir and approximately 700 feet north of the boundary line between Shelburne and Colrain, the capacity of the storage reservoir to be 5,000,000 gallons.

The Board has caused the locality to be examined by one of its engineers and samples of the water of the brook to be analyzed, and has considered the plans presented. The flow of Fox Brook in dry weather above the point at which it is proposed to take water would be insufficient for the requirements of the village, but by the construction of a storage reservoir holding at least 5,000,000 gallons and by preventing serious loss of water by leakage from the dams or other works, it will be practicable to secure enough water from this source for the reasonable requirements of the village at the present time. The watershed of the reservoir contains only two dwelling houses, one of which is so situated that drainage from it is likely to pollute the water, and the Board recommends that the property known as the Roberts farm be acquired at once and the use of the buildings discontinued. Further sanitary precautions, including the enforcement of rules and regulations for the sanitary protection of this watershed, should be taken before the water is used. It will also be important in the construction of the reservoir to remove all soil and organic matter from the area flowed, to prevent injury to the quality of the water.

With these recommendations the Board consents to and approves the taking of Fox Brook as a source of domestic water supply by the Shelburne Falls Fire District, as shown upon the plans presented, under the provisions of chapter 644 of the Acts of the year 1911.

SOUTH HADLEY (FIRE DISTRICT NO. 2).

JAN. 5, 1911.

To the Board of Water Commissioners of Fire District No. 2 of the Town of South Hadley.

GENTLEMEN: — The State Board of Health received from you on Dec. 20, 1910, the following application for the approval of the location of a well near Elmer Brook as a source of public water supply for Fire District No. 2, under the provisions of chapter 529 of the Acts of the year 1909: —

> The water commissioners of Fire District No. 2, South Hadley, Mass., submit for your approval the following description of the proposed water supply for Fire District No. 2 in the town of South Hadley. At present one open well 25 feet in diameter and 12 feet in depth (below the natural surface) has been completed. The well has a capacity of approximately 40,000 gallons.
>
> During the construction tests were made to determine the quantity of water available. In November a 24-hour test was made and the quantity was found to be 70 gallons per minute. Another 8-hour test was made on December 13, the result being the same as above. During the construction it has been found necessary to keep a steam pump running the greater part of the time.
>
> It is now proposed to construct a collecting trench or gallery along the foot of the bank as shown on the accompanying plan, the gallery to discharge the collected water into the open well from which it will be pumped into the system.
>
> The result of examinations along the foot of the slope would indicate that from 50 to 60 gallons per minute can easily be obtained in this way during the present extreme dry season. If on completion of this trench it is found that the quantity is not sufficient for the needs of the district, another well similar to the one already constructed will be built.
>
> It is thought that the amount of water necessary for the present needs of the district will not exceed 150,000 gallons per day. If a larger quantity is required it can be secured by additional wells. The water as shown by analysis made by your Board on November 15th is of excellent quality.
>
> In accordance with the Acts of 1909, chapter 529, the commissioners desire the approval of the State Board of Health on the location of the well and its use as a public water supply, in order that the town may install a water system as speedily as possible to relieve the present serious shortage.

The Board has caused the well and the adjacent collecting trench along the foot of the slope to be examined by one of its engineers and samples of the water of the well to be analyzed. The results of the analyses show that the water is of good quality for domestic purposes, and an examination of the locality shows that there are no dwelling houses or other possible sources of pollution in the neighborhood of the well at the present time which might have an unfavorable effect upon the quality of the water.

The quantity of water which the well and collecting trench are capable of yielding, so far as can be judged from the tests thus far made, will probably be sufficient for the present needs of the district with economical use, and it is probable that the supply may be materially increased by constructing other wells or collecting galleries in the valley of the brook.

The Board hereby approves the location of the well and collecting trench or gallery in the valley of Elmer Brook as sources of water supply for Fire District No. 2 of the town of South Hadley, as indicated on the plan presented, under the provisions of chapter 529 of the Acts of the year 1909, as amended by chapter 337 of the Acts of the year 1910.

SUDBURY.

DEC. 7, 1911.

To the Water Supply Committee, Sudbury, Mass.

GENTLEMEN: — The State Board of Health has considered your application for advice as to a proposed water supply for the town of Sudbury, to be taken from the ground in the valley of Hop Brook and a small tributary of that stream, about three-quarters of a mile southwest of Sudbury Center, and has caused the locality to be examined by one of its engineers and a sample of water from a test well in that region to be analyzed.

The soil in the region indicated appears to be coarse and porous, judging from surface indications, and a test well in this locality penetrated a porous soil from which water could be pumped quite freely. Samples of water collected from this test well were found upon analysis to be of good quality for domestic purposes. The Board recommends as the next step in your investigation that several test wells be sunk in this neighborhood and water pumped from them continuously for a period of several days at a rate as great as would be required for the supply of the town, observing the lowering and rise of water in the ground adjoining. The Board will assist you in further investigations by making the necessary analyses of water, and will give you further advice when the results of further tests are available. It is advisable to locate the test wells north of the present test well and as far as practicable from Hop Brook.

TAUNTON.

JUNE 8, 1911.

To the Board of Water Commissioners of the City of Taunton.

GENTLEMEN: — The State Board of Health, acting under authority of chapter 467 of the Acts of the year 1907, recommends that no permits be granted for boating, fishing or ice cutting on that portion of Assawompsett Pond which lies within one-fourth mile of the intake of the Taunton water works at Assawompsett Pond, except that boatmen be allowed to cross these waters in passing from one part of the pond to another.

The Board further recommends that no permits be required hereafter for boating, fishing or ice cutting on the portion of the pond east of a line drawn from the Nemasket River to a point one-fourth mile west of the mouth of Tamett Brook.

TOWNSEND.

MARCH 2, 1911.

To the Committee on Water Supply, Townsend, Mass.

GENTLEMEN: — The State Board of Health received from you on Feb. 15, 1911, an application for its advice as to taking water for the supply of Townsend from a pond known as Vinton Pond, situated in the western part of the town, and in response to this application has caused the pond and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water of this pond is soft, colorless and of good quality for water supply purposes. The watershed contains apparently but two dwelling houses and a few other buildings, all of which are unoccupied at the present time, and there is no doubt that the purity of the water can be protected at small expense. In the opinion of the Board, this source is an appropriate one from which to take a water supply for Townsend.

It appears to be possible, instead of taking water directly from the pond, to obtain it from the ground in its neighborhood, and thus secure the advantages of a ground-water supply, using the water of the pond only in case of emergency; and the Board recommends that before works are finally constructed for providing a water supply for the town from this source, the practicability of obtaining a ground-water supply by gravity from the neighborhood of Vinton Pond be given thorough consideration.

SEPT. 7, 1911.

To the Committee on Water Supply, Townsend, Mass.

GENTLEMEN: — In accordance with your request for a further examination of Vinton Pond in Townsend and advice as to whether the quality of the water has undergone any material change since the previous examination was made, the Board has caused the pond and its surroundings to be examined and samples of the water to be analyzed.

The results of the analyses show that there has been no material change in the quality of the water since the previous examination in February, and the recent investigations fail to show the existence of any conditions affecting this pond which would prevent its being maintained in a thoroughly satisfactory condition as a source of public water supply. Under the circumstances, the Board sees no reason to change the advice given you under date of March 2, 1911, a copy of which is appended hereto.

WAKEFIELD.

OCT. 24, 1911.

To the Special Committee on Water Supply, Wakefield, Mass., MR. HARRIS M. DOLBEARE, *Secretary.*

GENTLEMEN: — The State Board of Health received from you on Sept. 8, 1911, the following application for advice relative to the water supply of the town of Wakefield: —

> No doubt you are aware that a special committee appointed by the town of Wakefield, is endeavoring to solve the water supply problem, for members of the water committee have had the privilege of interviewing your representatives at various times.
>
> At our meeting last night it was voted that we submit the following questions to your honorable board for consideration: —
>
> Would you approve the use of the waters of Lake Quannapowitt as an auxiliary water supply to Crystal Lake water and the filtering of these waters by slow sand filtration as advised by Engineer W. S. Johnson in his report to the Wakefield water and sewerage board, which we enclose for your inspection, provided the town should decide to use the waters of both lakes?
>
> Do you consider that the waters of both lakes would furnish an adequate supply?
>
> In your opinion what would be the probable duration of the supply considering the natural growth of the population of the town of Wakefield?
>
> Which course in your opinion would be the better one for the town of Wakefield to pursue — the use of filtered water from both lakes; or for the town to enter the metropolitan system?
>
> We are taking the liberty to ask these questions in view of your expressed willingness to advise the town in respect to its water problems.

We are holding meetings very frequently, realizing the importance of the question and would appreciate a reply as soon as you can conveniently advise us.

The Board has considered your application and the report presented therewith and has examined the available information as to the quality of the waters of Crystal Lake and Lake Quannapowitt and the quantity of water which these sources might be expected to yield if used together for the water supply of Wakefield.

It is obvious from the experience of the past two years that the capacity of Crystal Lake is hardly sufficient for the present requirements of the town in dry periods, and a permanent source of additional supply has now become necessary. Lake Quannapowitt, from which it is proposed to take the additional supply, has an area of 230 acres and a watershed area, including the surface of the lake, of about 4⅛ square miles. The lake is evidently very shallow, judging from a limited number of soundings about its shores, and considerable areas of its bottom would be exposed by lowering the level of the water. The lowering of the lake to a level 2½ feet below high water would apparently expose as much as 20 acres of its bottom; if lowered 4½ feet about 50 acres would be exposed, and at 6½ feet about 85 acres. The level of the lake falls naturally from evaporation in very dry seasons to a level considerably below high water. Considering the density of population about the southerly and easterly shores of the lake and its use as a resort for considerable numbers of persons, especially in summer, the lowering of the water to any considerable extent in the drier portion of the year would be likely to create objectionable conditions.

Under the circumstances, it appears to the Board desirable to limit the use of water from Lake Quannapowitt to the quantity that would naturally overflow from the lake in the winter and spring. Assuming that the use of water from Lake Quannapowitt would be limited as suggested, the quantity of water that could be obtained from Crystal Lake and Lake Quannapowitt used together would probably not, in very dry periods, exceed 1,200,000 gallons per day.

Statistics of the population of the town of Wakefield indicate that the population has about doubled in the past twenty-eight years. It is likely that the town will grow somewhat faster in the future, and if it is assumed that it will double in the next twenty-five years Crystal Lake and Lake Quannapowitt used together as above would, at the same rate of consumption per person as in 1910, provide an adequate supply for about eighteen years. The quantity of water used per inhabitant in the town of Wakefield in the year 1910 was 61 gallons. This use is not an unreasonably large one and is considerably less than the quantity that has been used by the town in former years. If the quantity used per person should increase to 74 gallons, the maximum amount which has been used in any recent year, Crystal Lake and Lake Quannapowitt used as outlined above would last the town for a period of about ten years. If the population should grow more rapidly — at such a rate that it would double in the next twenty years — the supply from the lakes used as above would be sufficient for about fifteen years, at the rate of consumption per inhabitant recorded in 1910; or, if the consumption should be as great as 74 gallons per person, the supply would be sufficient for about eight years.

If the plan of continuing the use of Crystal Lake, supplemented with water from Lake Quannapowitt, should be adopted, filtration of all of the water supplied to the town would be essential, since Lake Quannapowitt is very badly polluted by sewage from the large population on its watershed and is exposed to much danger of contamination from its use as a resort for large numbers of persons for boating, fishing, skating, etc. Filtration is also very desirable for the removal from the water of Crystal Lake of the organic growths by which the water of this lake has at times been affected seriously in the summer season, especially in the last few years. By efficient filtration as suggested in the plan presented, there is no doubt that water could be supplied to the town from the lakes which would be safe for drinking, practically clear and odorless and with but little color. In its appearance it would differ but little in most respects from the water supplied by the Metropolitan Water District, but the water from the lakes would be much harder, though the hardness would not be excessive.

The selection of the best course for the town of Wakefield to adopt — whether to use the filtered water from the lakes or to enter the metropolitan system — will necessarily depend to a considerable extent upon the comparative cost of the two schemes. There is little reason to doubt that the town must eventually, if it continues to grow, join the Metropolitan District in order to secure an adequate supply of good water, and under the circumstances the question to be determined is whether it will be best to enter the district in the beginning or to incur the expense necessary to secure an adequate supply of safe water from Crystal and Quannapowitt lakes and postpone entering the Metropolitan District for at least eight or ten years and perhaps for a longer time.

From the estimates of cost which have been submitted it appears to the Board probable that the cost of the works necessary for developing a supply from the lakes, including all items, would be nearly as great as the cost of entering the metropolitan system at the present time. If the works for supplying filtered water from the lakes should be built, and the town should subsequently enter the metropolitan system, these works would be of little, or no, further value.

Under these conditions it is doubtful whether the town would make a material financial saving if it were to develop a supply from the lakes as proposed and should subsequently find it necessary to enter the metropolitan system within the next ten years. If the growth of the town should prove to be less rapid than now seems reasonable to expect, or if the consumption of water can be kept at a lower level than now seems likely, the supply from the lakes might last for more than ten years and a saving be effected in the cost of the water supply by using the water of the lakes instead of joining the metropolitan system at the present time; but the fact should be taken into consideration that while the consumption of water in Wakefield has been kept at a reasonably low rate, the tendency in American cities and towns is toward a gradual increase in the consumption of water even in towns quite thoroughly metered, and there are many towns in which the use of water per person is considerably greater than in Wakefield, though the conditions affecting the use of water appear to be quite similar.

On the whole, as nearly as can be judged from present conditions, it is likely to make very little difference to the town of Wakefield in the long run from a financial point of view whether the town joins the Metropolitan Water District at the present time or develops an independent supply from Crystal and Quannapowitt lakes in the manner proposed. From the point of view of the quality of the water, the metropolitan supply would be preferable.

If legislative action should be obtained which would so far modify the provisions of section 19 of chapter 488 of the Acts of the year 1895 (known as the "Metropolitan Water Supply Act") as to allow a greater value than $12 per million gallons for water supplied from existing sources controlled by the town, — and it appears to the Board that such an allowance may properly be made, — then the advantage would probably be decidedly in favor of the early admission of the town to the Metropolitan Water District.

WAREHAM (ONSET).

SEPT. 13, 1911.

To the Onset Water Company, Wareham, Mass.

GENTLEMEN: — Complaint having been made of the condition of the water supplied by your company in the village of Onset, the State Board of Health has caused the source of supply, Jonathan Pond, and its surroundings, to be examined and samples of water distributed in various parts of the village to be analyzed.

The results of these and previous examinations show that the water of Jonathan Pond is free from coloring matter, contains extremely small quantities of organic and mineral matter and is practically without hardness. There are no sources of pollution in its neighborhood, and it is one of the best of the surface water supplies in use in the State.

Examinations of the water of the distributing system show that in the late spring the water contained considerable iron rust, but in the summer samples of water from faucets in the village were found to be unobjectionable. It appears that the principal use of water from this system is in the summer season and that very little water is used during the period of the year extending from October to May. The water consequently remains for long periods of time in the standpipe and in the pipes of the distributing system. During this period the water, which is saturated with oxygen and very low in mineral matter, acts somewhat upon the pipes and considerable rust accumulates within them, in consequence of which the water drawn from the faucets in the early part of the year is affected by the presence of considerable iron. It is probable that if the system were thoroughly and frequently flushed in the late spring or early summer, the rust accumulating in the winter season could be flushed out of the pipes and removed from the standpipe, and the objectionable conditions now complained of prevented.

SEPT. 13, 1911.

To the Board of Health of the Town of Wareham.

GENTLEMEN: — Complaint having been made of the condition of the water supplied to the village of Onset, the State Board of Health has caused the source of supply and the water distributed in the village to be examined, and finds that the objectionable conditions can probably be removed by frequent and thorough flushing of the pipes of this system in the early spring, and the Board has so advised the Onset Water Company. A copy of this communication is appended hereto.

WEST BROOKFIELD.

OCT. 5, 1911.

To the Board of Water Commissioners, West Brookfield, Mass., MR. WILLIAM R. TRAILL, *Clerk.*

GENTLEMEN: — The State Board of Health received from you on Sept. 8, 1911, a communication stating that you are planning to supply the town with water from one of two sources by means of a group of driven wells or a large well, one of the sources mentioned being the ground at the foot of Foster Hill, some distance east of Tanny Brook, and the other the ground near the south shore of Wickaboag Pond.

In response to this application the Board has caused the locality to be examined by one of its engineers and samples of water from test wells in the localities indicated to be analyzed. At the first source mentioned, at the foot of Foster Hill, it appears that seven wells have been driven in the valley of Tanny Brook, or Coys Brook, as it is marked on the State map, all of which apparently encountered ledge at an average depth of about 27 feet. The soil penetrated is said to have consisted almost entirely of clay, with a porous stratum of coarse sand directly overlying the ledge, the maximum thickness of this stratum being about 2 feet, while in some of the wells it was less than a foot. These conditions are not favorable for obtaining water in large quantities from wells in this locality.

A sample of water collected from one of the wells in this group on September 20 was found to be turbid and highly colored and contained an excessive quantity of organic matter and iron. Considering the results of this analysis, it is improbable that water of suitable quality for domestic purposes can be obtained from the ground in this locality.

At the location near the southerly shore of Wickaboag Pond, where a test well was recently driven, the conditions appear to be favorable, so far as can be judged from the limited investigation thus far made, for obtaining water freely from the ground, and samples of water from test wells in this locality were found to be of good quality for domestic purposes. Further tests will be necessary, however, before it can be determined definitely whether an adequate supply of good water for all the requirements of the town can be obtained from the ground in this region. The locality appears to be the most favorable one of all those examined with reference to obtaining a water supply for the town, and the Board recommends that you cause further wells to be put in in this locality, and, if the conditions continue to be favorable, it is advisable to connect several wells and pump from them for a period of at least one week, to ascertain as definitely as practicable the quantity and character of the water obtainable from the ground in this region. The Board will assist you in the further investigation by making the necessary analyses of water and will give you further advice in the matter, if you so request, when the results of these investigations are available.

WESTON.

JAN. 5, 1911.

To the Weston Water Company, Weston, Mass.

GENTLEMEN: — The State Board of Health received from you on Dec. 17, 1910, through your engineer an application for advice relative to taking water for the supply of the town of Weston from the ground near Stony Brook, about 1,000 feet southeast of the Silver Hill railroad station, accompanied by a plan showing the location of test wells recently driven in this locality and a description of a pumping test, made by pumping from a group of six wells for a period of about seventeen days from November 28 to December 15.

It appears that the wells are located in low ground near Stony Brook and were sunk through a layer of peaty soil from 2 to 5 feet in thickness into coarse sand or gravel, underlaid by hardpan at a depth of 30 feet from the surface. The records show that water was pumped from the wells at a rate of 150,000 gallons per day during the first four days of the pumping test and subsequently for eleven days at a rate of 250,000 gallons per day, the rate then being reduced to about 175,000 gallons per day until the test was discontinued on December 15. Observations of the height of the ground water in the neighborhood of the wells during and after the test, together with information as to the quantity pumped, indicate that an adequate supply of water for the requirements of Weston can be obtained from the ground in this locality.

The results of analyses of samples of water collected and sent in by you during the test show that it is slightly harder than the water of the Kendal Green wells recently tested, but does not differ from it materially in other respects, and, in the opinion of the Board, the proposed source is likely to furnish water of good quality for domestic purposes.

Of the two sources, that at Kendal Green appears to be somewhat preferable, being in a less populous district and in a location free from peaty soil.

In case water is taken from the ground at the location near Silver Hill, as now proposed, it will be important for the water company to secure control of a considerable area of land, especially west and north of the wells, between them and North Avenue and the railroad and Merriam Street, in order to protect the quality of the water.

WILBRAHAM (COLLINS MANUFACTURING COMPANY).

DEC. 7, 1911.

To the Collins Manufacturing Company, North Wilbraham, Mass.

GENTLEMEN: — A recent examination of the sources of water supply of the mills and tenements connected with your works at North Wilbraham shows that in the past water has been drawn in part from a reservoir about 1,000 feet west of the mill, from which it is supplied for drinking and domestic purposes in the mill and tenements after filtration, and in part from the river, from which the water, after filtration, is supplied for general use in the mill. It appears that until recently there were several connections between the system supplied from the river and the system supplied from the reservoir, but that these connections have been closed, so far as practicable, so that the drinking water supply is drawn chiefly from the reservoir. River water, however, is allowed to enter the reservoir at times, and was found to be entering the reservoir at the time of one of the recent examinations.

It appears further that the quality of the water supplied from faucets in the mill and tenements in the summer season is objectionable on account of its high temperature and bad taste, and that at such times the employees in the mill and houses have taken water from various springs and wells in the neighborhood of the mill.

Of these the Ludlow Spring, so called, located on the north side of the river, is a shallow excavation a few feet from the river at the end of a culvert under the railroad. When examined the surroundings were filthy and no protection had been provided to prevent surface water from entering the spring. The spring may also be flooded by a rise in the river, and, under the existing conditions, this spring must be regarded as an unsafe source from which to take water for drinking.

Another spring located near the head of a ravine above the reservoir, southwest of the mill, was closed up and is unused; and a third spring, situated a short distance from the one just described, was also closed at the time of the examination. The water of the Fitzgerald well, so called, was found upon analysis to be badly polluted and unsafe for drinking.

It is evident that a supply of good water, suitable for drinking and domestic purposes, is greatly needed in the mill and tenements near by, and the Board recommends that a supply of good water be provided without delay. The circumstances are such that it is probable that a supply of good ground water can be obtained in the neighborhood, and such a supply would probably be far more satisfactory than water from any of the surface sources, even if thoroughly filtered, for the reason that a good ground water would at all times be free from color, taste and odor, and if properly stored and distributed would have a much lower temperature in the summer season than water from any surface source unless artificially cooled. The Board recommends that a suitable water supply for drinking and domestic purposes be provided in the mill and tenements as soon as practicable.

The Board will assist you in securing a suitable water supply, if you so request, by testing any water which you may propose to use.

WORCESTER.

JAN. 5, 1911.

To Mr. GEORGE W. BATCHELDER, *Water Commissioner, Worcester, Mass.*

DEAR SIR: — The State Board of Health has considered your application relative to the use of Coes Reservoir and Lake Quinsigamond as temporary sources of water supply for the city of Worcester, and has caused these sources to be examined and samples of their waters to be analyzed.

The water of Coes Reservoir does not differ materially in appearance or in general characteristics from the waters of your present sources of water supply, but the watershed of the reservoir contains a considerable population and receives apparently all of the drainage from a woolen mill located on the stream above the reservoir. The water of Lake Quinsigamond is of much poorer quality than that of your present sources, and the lake is exposed to danger of pollution by sewage from the insane hospital and from other sources. Under existing conditions neither source is, in the opinion of the Board, a safe one from which to take water for domestic use.

Considering the circumstances, there appears to be no better plan of obtaining an additional water supply for the city for use in case of immediate emergency than to introduce water from Coes Reservoir, and in case it becomes necessary to use water from this source the Board recommends that the inhabitants of the city be warned to boil all water used for drinking.

MARCH 23, 1911.

To Mr. GEORGE W. BATCHELDER, *Water Commissioner, Worcester, Mass.*

DEAR SIR: — In accordance with your request for advice as to a temporary water supply for the city of Worcester the State Board of Health has examined the present sources of water supply and the sources from which an adequate quantity of water might be obtained temporarily for the supply of the city, and has considered the plans which you and the city engineer have outlined for taking water from Lake Quinsigamond and supplying it to the city after purification. A temporary taking of water from this source can probably be made under the provisions of chapter 25, section 35, of the Revised Laws of Massachusetts.

It appears from the information available to the Board that the quantity of water in store in the various reservoirs is less than one-third of their full capacity, and a calculation of their probable yield indicates that if the coming year shall be as dry as the years which have been recorded on the Sudbury River and the consumption of water shall be about the same as last year, the reservoirs will be exhausted before midsummer. Even in a year of greater rainfall than the minimum the exhaustion of the reservoirs is likely to occur before the end of the year unless the rainfall should be greater than the average. Considering the circumstances it appears to the Board important that provision should be made for taking water from some available source adequate to furnish more than 1,000 million gallons, — the quantity which will be required in case the conditions of last year should be repeated.

An examination of the sources in the vicinity of the city shows that the only source from which it is probable that an adequate quantity of water to meet the additional needs of the city can be obtained within the time available is Lake Quinsigamond. The shores and watershed of this lake are thickly populated in the summer season, and if it is necessary to take the water directly into the pipes of the city, it would be unsafe for drinking unless boiled. An examination of the westerly shore of the lake north of the Worcester turnpike shows that the soil in this region is apparently coarse and porous, and it is probable that the lake water could be efficiently purified by pumping it upon prepared areas in this region and filtering it intermittently in the same manner in which water has been filtered at other places. These areas can be prepared in a manner similar to sewage filters at a comparatively small expense, and it is probable that an area of from two to three acres would be adequate for the purpose.

It is not impossible, moreover, that an adequate supply of water safe for drinking might be obtained from groups of tubular wells at various points along the shore of the lake north of the turnpike, and if a suitable supply can be obtained from the ground in this region by means of wells, the best plan would probably be to take water in this way, and in case the yield should prove less than desirable it might be increased by pumping water from the lake upon prepared areas in the neighborhood of the wells.

The Board recommends that tests be made as soon as possible to determine the practicability of obtaining water from the ground near the western shore of the lake north of Belmont Street by means of tubular wells. The Board will upon request assist you in these investigations by making the necessary analyses of water and will give you further advice as further information becomes available.

JULY 21, 1911.

To His Honor JAMES LOGAN, *Mayor of the City of Worcester.*

DEAR SIR: — In response to your request, the State Board of Health has considered the present condition of the water supply of the city of Worcester, the necessity for an emergency supply and the character and capacity of the sources from which water for use in the immediate future can be obtained.

The quantity of water in the reservoirs supplying the high service districts appears to be sufficient to meet the requirements of those districts for several months, but it may not be sufficient if the conditions of 1910–11 are repeated, and all practicable measures for restricting unnecessary use and waste of water should be continued and strictly enforced. The supply in the low service reservoirs is sufficient to meet the requirements of the low service districts only for a very limited time.

It appears from the information presented that it is possible to obtain an additional supply of about 150,000,000 gallons by diverting the water of Pine Hill Reservoir in the Asnebumskit watershed into the Holden Reservoir system, and it further appears that if the necessary means are provided, the discharge of this water into the Holden reservoirs can be begun in about ten days. In the opinion of the Board this reservoir is a proper source of water supply for use in meeting the present emergency and the Board recommends that works for the diversion of this water be begun at once and completed as soon as possible.

A consideration of all of the sources of water supply in the vicinity of the city has shown that the only source from which it is probable that an adequate quantity of water can be obtained to meet the present emergency and provide a sufficient supply for the city within the shortest time is Lake Quinsigamond. On account of the large population about the shores of this lake, especially at the present season of the year, its waters would be unsafe to use for drinking unless boiled, but an examination of the western shore of the lake north of the Worcester turnpike has shown that the soil in the territory bordering the lake is apparently coarse and porous, and indications are favorable for obtaining a large quantity of water from the ground in this locality by means of tubular wells or other suitable works. Moreover, if the character of the soil is favorable, the lake water could be efficiently purified by pumping it upon prepared areas in this region and filtering it intermittently, as is done at other places. The best plan will probably be, in case the conditions are sufficiently favorable, to take water from tubular wells along the shore of the lake and in or near the depressions west of the highway which borders the lake in this region, and to supplement the supply obtained in this way, if necessary, by pumping water from the lake upon prepared areas in the neighborhood of the wells.

It appears from the information presented that the best available plan of supplying this water to the city in the shortest time practicable is to pump it through a main laid throughout most of its length on the surface of the ground in or near Belmont Street to Bell Pond, from which the water can be delivered into the low service system. The water now in Bell Pond should be drawn off and the pond put into a proper condition before it is used.

The Board recommends that the sinking of wells near Lake Quinsigamond, the cleaning of Bell Pond and the laying of the forcemain be begun at once, and that steps be taken immediately to secure temporarily at least the use of the necessary pumps and machinery to deliver a sufficient quantity of water into Bell Pond. By working night and day it is possible that the works can be completed in time to introduce a supply of water from the neighborhood of Lake Quinsigamond before the low service reservoirs, supplemented with such waters as can be obtained from the Asnebumskit watershed, become exhausted.

It is understood that pumps and works can readily be made available for taking water from Coes Pond, but, in the opinion of the Board, the conditions affecting the water of this pond at the present time are very objectionable and water from that source should be introduced into the water supply system of the city of Worcester only in case of extreme emergency and as a last resort, to prevent the pipes from becoming empty.

The Board will be pleased to give you promptly any further advice or assistance that it can in developing a temporary water supply near Lake Quinsigamond or in connection with any other matters connected with your water supply.

AUG. 10, 1911.

To GEORGE W. BATCHELDER, Esq., *Water Commissioner, Worcester, Mass.*

DEAR SIR: — Yesterday communication was sent to you in response to your telephone message which was understood to request the opinion of the State Board of Health upon the quality of the water taken from wells in Kendall Basin. Now your letter of yesterday is received, asking if the Board will grant permission to use this water in the city, in the present emergency.

Such permission is hereby fully granted by the Board. From the data which the Board now has in regard to this locality it can expect only a few days' supply for the city from this source, until rain falls.

It is understood that you have several wells driven. It would be well to have all but one of these connected and pumped from and the height sustained in the omitted one noted, to indicate clearly how much water you can draw from this source.

AUG. 29, 1911.

To Mr. GEORGE W. BATCHELDER, *Water Commissioner of the City of Worcester.*

DEAR SIR: — The State Board of Health has considered your application for the approval of the use of the waters of Eagle Lake in the town of Holden and Asnebumskit Pond in the town of Paxton, as sources of water supply, to be used in the present emergency in the city of Worcester, and has caused samples of the waters of these sources sent in by you to be analyzed.

The waters appear to be suitable for domestic use, and the Board hereby approves these waters as proper sources of water supply in the present emergency. It will be necessary while the water is being withdrawn from Eagle Lake to prevent danger of the pollution of that source by the laborers and others within the watershed.

In accordance with your further request for an examination of the water of Turkey Hill Pond in the towns of Rutland and Paxton the Board has also caused samples of water which you have supplied from that source to be analyzed, and finds that while the water is of somewhat poorer quality than that of the other sources mentioned, — having more color, — it is in other respects satisfactory and the Board approves this water as a proper source of water supply to relieve the present emergency.

WORTHINGTON (FIRE DISTRICT).

JULY 6, 1911.

To the Board of Water Commissioners of the Worthington Fire District, Mr. JOHN D. WILLARD, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on May 23, 1911, an application requesting approval by the Board, under the provisions of chapter 233 of the Acts of the year 1911, of a proposed water supply for the Worthington Fire District, the supply for the main portion of the district, — the villages of Worthington Center and Worthington Corners, — to be taken from the Rice springs, so called, situated about a mile northwest of Worthington Corners, and the supply for the village of Ringville to be taken from a small pond and brook a little less than a mile northwest of that village.

The application is accompanied by plans and a report by your engineer describing the proposed works. From this information it appears that three sources have been considered for the supply of Worthington

Center and Worthington Corners, one being the Rice springs already mentioned, the second the Hewitt and Church springs and the third the Allen springs. It appears that the Hewitt and Church springs are located at too low an elevation to be of value for fire protection and that the elevation of the Allen springs is less than desirable for that purpose.

The Rice springs are located in the valley of Wards Stream, so called, near its headwaters, and the plan of your engineer provides for constructing a dam and storage reservoir on this stream, which, it is estimated, will have a capacity of about 1,000,000 gallons, at a point about three-quarters of a mile northwest of Worthington Corners. About 1,100 feet southwest of this reservoir it is proposed to construct another reservoir or well, having a capacity of about 500,000 gallons, into which it is proposed to conduct the waters of a part of the springs, allowing the remainder to flow to the main reservoir.

A house and barn are situated near the headwaters of the brook above the proposed reservoir, drainage from which might injure the quality of the water, and it is proposed to construct a dike to divert drainage from these buildings to a point outside the watershed.

The Board has caused the locality to be examined by one of its engineers and samples of the waters of the various springs to be analyzed, and has considered the plan presented. The waters of the springs and of the stream on which it is proposed to construct the reservoir are naturally of good quality for water supply purposes, though at present they are exposed to pollution from the buildings mentioned above.

Information as to the flow of the springs and brook indicates that at the present time the yield of these sources would probably be sufficient for the requirements of the Worthington Fire District, but no measurements are available to show the flow of the stream in the drier portion of a dry season, though the information submitted to the Board indicates that the brook does not dry up and that the flow of water was quite constant during the drier portion of last year when the flow of streams was very small.

So far as can be judged from the information available, it appears to the Board probable that a sufficient quantity of water for the requirements of the Worthington Fire District can be obtained from the watershed of the proposed reservoir on Wards Stream, including the Rice springs. It is likely, however, that the water of the proposed reservoir would be affected at times by growths of organisms and objectionable tastes and odors, as is usually the case with ground waters exposed to light in open reservoirs, and it would probably be better to construct in the beginning in the neighborhood of the proposed dam a large well with its bottom considerably below the level of the brook, and divert into it the water of the stream and of the various springs. In this way it is likely that a larger proportion of the ground water could be collected and a somewhat greater yield secured in the drier portion of the year. If a greater storage should be found necessary, a reservoir could be constructed above the well at some future time.

The details of the dike for diverting the drainage from the buildings on the watershed are not presented, but it is probable that danger of pollution of the water could be prevented by a properly constructed dike or drain to remove the drainage from these buildings. It would be better, however, for the district to acquire control of the buildings and discontinue their further use, and in this way the loss of a considerable quantity of water, made necessary by the diversion of drainage from the buildings, would be avoided.

The Board recommends that the pipes connecting the springs with the proposed wells and reservoir be laid with open joints covered and surrounded with gravel, so as to collect all the ground water practicable along their course.

With the modifications suggested the Board approves the plan of taking water for the supply of Worthington Corners and Worthington Center from the Rice springs and the headwaters of Wards Stream, so called, as shown on the plan presented with your application.

For the water supply of Ringville it is proposed to utilize a small natural pond and a stream which can readily be diverted into this pond, both of which are located a short distance northwest of the village. It is also suggested that water from the Rice springs might be diverted into the brook if the supply from the source mentioned should prove inadequate. An examination of the small pond shows that it has a muddy bottom, but no information is submitted showing the depth of mud or the probable quantity of material that it would be necessary to remove in bringing it to a proper condition as a source of domestic water supply. At the present time the water is highly colored and contains an excessive quantity of organic matter and iron, and would be objectionable for domestic purposes. It is advisable that before the use of this source is definitely decided upon, the cost of its development be more definitely determined and a further investigation made to determine whether it may not be practicable to secure a better supply from some other source in this region.

In addition to the foregoing, the Board has advised the following cities, towns and persons relative to spring waters, waters used for the supply of factories, public wells or wells used by a number of families; but as these matters are for the most part of minor importance, the communications of the Board in these cases have not been printed. Copies of them are on file in the office of the Board.

Acushnet, wells at Long Plain.
Amesbury, well of Hamilton Woolen Company.
Andover, spring.
Ashby, well at Lyman School.
Ashby, Hayward Spring.
Attleborough, spring and wells of R. Wolfenden & Sons (two).
Auburn, wells at schools.
Auburn, wells in Pondville (two).
Barre, well of Barre Wool Combing Company.
Beverly, wells of United Shoe Machinery Company.
Beverly, spring.
Bridgewater, well of Henry Perkins Company.
Chelmsford, well in West Chelmsford.
Concord, spring at hospital.
Danvers, spring.
Dartmouth, well in South Dartmouth.
East Bridgewater, well at Beaver School.
Falmouth, well at Falmouth Heights.
Georgetown, spring.
Hyde Park, wells of the Stafford Company in Readville.
Lawrence, well of Pacific Mills.
Lynn, wells of Lynn Grease Extracting Company.
Lynn, well of G. F. Ames & Co. Monumental Works.
Lynn, well of Hilliard & Merrill.
Lynn, spring.
Malden, well of Bettinson-Harris Laundry Company.
Marshfield, well at Marshfield Hills.
Medford, well of Joseph Woods & Son Corporation.
Milton, spring.
Newton, spring of Saco-Pettee Company.
North Attleborough, well.
Norwood, well.
Peabody, well of Hunt-Rankin Leather Company.
Peabody, Hill Top Spring.
Peabody, Myles Standish Spring.
Plymouth, well of Standish Worsted Company.
Plymouth, well at Manomet Bluffs.

Plymouth, Summer's Spring.
Rowley, well.
Rowley, well at boys' camp.
Salem, well on Bakers Island.
Sandisfield, spring in Montville.
Southbridge, Glover's Spring.
Southbridge, well.
Weston, wells.
Westport, well at Y. M. C. A. Camp.
Wrentham, well at Sheldonville.

ICE SUPPLIES.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to sources of ice supply: —

HANOVER.

JUNE 1, 1911.

To the Board of Health, Hanover, Mass.

GENTLEMEN: — In response to your request for an examination of the water of a pond used as a source of ice supply at Hanover and advice as to its fitness for that use, the Board has caused the pond and its surroundings to be examined and a sample of the water and ice harvested from the pond during the past winter to be analyzed.

The results of the analysis show that the water is badly polluted and contains a large quantity of organic matter, and an examination of the watershed shows that polluting matters from barns and cesspools are at present finding their way into the pond or its feeders.

An analysis of a sample of ice taken from an ice-house on the shore of the pond shows that, while it contains a somewhat larger quantity of organic matter than is found in good ice, the numbers of bacteria are low. This ice was about 1 foot in thickness, including 2 inches of snow ice. It is probable that if all of the snow ice, including the first inch of clear ice which formed beneath the snow ice, should be removed, the ice now stored could be used with safety for domestic purposes. It is probable that the conditions under which ice was formed on this pond during the past winter were more favorable than might be the case in other years, and the Board recommends that the pollution of the pond be prevented before the beginning of another winter, if the use of this pond as a source of ice supply is to be continued.

MANCHESTER.

OCT. 18, 1911.

To Mr. ADDISON DAVIS, *Preston Place, Beverly Farms, Mass.*

DEAR SIR: — In response to your request for an examination of certain proposed sources of ice supply in Manchester and advice as to the probable quality of ice to be obtained therefrom, the Board has caused the sources to be examined by one of its engineers and samples of their waters to be analyzed.

The sources in question are three small ponds located on a brook west of Pine Street, a short distance west of the main village of Manchester and about 750 feet northwest of Bridge Street. The largest of the three ponds is located at the junction of the brook with the main tributary from the east, and the two smaller ponds are located on this tributary. The results of the examination show that within the watershed of the tributary there are a number of dwelling houses and several places from which the stream is likely at times to be so seriously polluted as to make the ponds on this tributary undesirable sources from which to take ice for domestic purposes. The main stream drains a sparsely inhabited territory, in which there are no serious sources of pollution, but the pond at the junction of the main stream and the east branch is affected by the quality of the water of the east branch. It appears to be practicable to divert the waters of the east branch around the lower pond through a channel already existing without serious difficulty. If the waters of the easterly tributary should be diverted from the lower pond, as suggested, the lower pond, in the opinion of the Board, would be a suitable source from which to take ice for domestic purposes. It is advisable that in using ice from this source all snow ice and the first inch of clear ice that forms upon the pond be removed and that all ice containing particles of foreign matter be rejected.

PEPPERELL.

FEB. 2, 1911.

To the Board of Health of the Town of Pepperell.

GENTLEMEN: — In response to your request for an examination of Reed's Pond in Pepperell and advice as to its use as a source of ice supply, the State Board of Health has caused the pond to be examined and a sample of the water and ice to be analyzed.

At the time of the examination the pond was found to be low, and dead fish were frozen into the upper 3 inches of the ice. Analyses of the clear ice below the upper 3 inches indicate that it may safely be used for domestic purposes provided it contains no particles of foreign matter.

SOUTHBRIDGE.

JAN. 5, 1911.

To Mr. ALBERT R. BROWN, *Agent, Board of Health, Southbridge, Mass.*

DEAR SIR: — In accordance with your request of Dec. 13, 1910, for an examination of an ice pond on Cady Brook about a mile north of Southbridge, near the road to Charlton City, and advice as to the quality of the ice for domestic purposes, the Board has caused the pond and its watershed to be examined and samples of the water and ice to be analyzed.

It appears from this examination that Cady Brook is very badly polluted by sewage and manufacturing wastes at mills and other establishments chiefly in the village of Charlton City, and that it receives also pollution from a laundry about a mile above the pond.

The results of the analyses show that the water of the pond is very badly polluted and that the snow ice found upon it in the latter part of December was also badly polluted and unfit for domestic use. The clear ice beneath the snow ice, while containing somewhat more organic matter than is found in good ice, did not show evidence of serious pollution.

In the opinion of the Board, the only way in which ice which may be used with safety for domestic purposes can be obtained from this pond is by removing from the ice before it is used all snow ice, including the first inch of clear ice that formed upon the pond and by rejecting all ice containing particles of foreign matter.

STOUGHTON.

FEB. 2, 1911.

To the Board of Health of the Town of Stoughton.

GENTLEMEN: — In response to your request for an examination of the water and ice of the Albert Southworth Pond, off West Street in Stoughton, and advice as to the use of the ice for domestic purposes, the State Board of Health has caused the pond and its surroundings to be examined and a sample of the water and ice to be analyzed.

The watershed of the pond appears to be nearly uninhabited and the pond is exposed to little danger of pollution. At the time the examination was made the ice upon the pond was 4½ inches thick and contained considerable foreign matter in the form of black particles, which may have come from the smokestacks at the neighboring pumping station or factory. It is probable that ice of good quality for domestic purposes can be obtained from this pond by avoiding the use of snow ice and removing, before the ice is used, the first inch of clear ice that formed upon the pond.

WINCHESTER.

APRIL 6, 1911.

To the Board of Health of the Town of Winchester.

GENTLEMEN: — The State Board of Health received from you on March 14, 1911, the following communication requesting an examination of ice taken from Cranberry Bog Pond in North Winchester and advice as to its use after storage in a barn cellar for the cooling of milk: —

> Mr. F. E. Chandler, owner of the Bay State Milk and Cream Company, has cut a lot of ice on what is known as the "Cranberry Bog" at North Winchester. He has stored some of this ice in his barn at 430 Washington Street, Winchester, and proposes to use it for cooling his milk next summer. There is grave doubt about the purity of this ice and also about the propriety of storing it under where his cows are standing.
>
> Will you kindly examine this ice and advise this Board as to its suitability for the use he intends to make of it.

The results of an examination of a sample of ice taken from the pond show that it contains a much greater quantity of organic matter than is found in good ice, and its storage under the circumstances described would tend to its further pollution. It appears to the Board that there is danger that in the use of this ice for the cooling of milk the milk may become contaminated thereby. This danger may be averted only by so handling the milk as to prevent contact with the ice or the water flowing from it.

SEWERAGE AND SEWAGE DISPOSAL.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to sewerage and sewage disposal: —

FAIRHAVEN.

JULY 6, 1911.

To the Board of Sewer Commissioners, Fairhaven, Mass.

GENTLEMEN: — The State Board of Health received from you on June 19, 1911, the following application for advice as to a proposed system of sewerage for the district known as Oxford Heights in the northerly part of the town of Fairhaven: —

> At the annual town meeting, held March 11, 1911, it was voted to instruct the sewer commissioners to construct a sewer in the north part of Fairhaven with outlet at the foot of Howland Road and empty into the Acushnet River. And we, the board of sewer commissioners of said town, respectfully ask your permission to construct and maintain the same. As this method seems

to be the only manner without great expense to the town, we would respectfully request that you give this matter due consideration. An early reply will be greatly appreciated.

The Board has caused the locality to be examined by one of its engineers and has considered the plan presented. The proposed outlet into the Acushnet River is to be located in the center of the easterly abutment of the bridge on Howland Road, about 350 feet beyond the shore line of the river. The depth of water at the proposed point of discharge is apparently 5 feet or more at mean low water, and, under the existing conditions, with the small quantity of sewage likely to be discharged at this outlet, it is improbable that objectionable conditions will be created at least for a few years in the future. It is desirable that the sewer be carried out from the abutment about 50 feet into the river, so that there may be at all times a considerable width of water between the abutment and the sewer outlet.

The Board is informed that all of the sewers in this district are to be constructed upon the separate plan and that storm water and ground drainage are, so far as possible, to be excluded. It is very important, in the opinion of the Board, that this plan be strictly adhered to, since it may become necessary or desirable before many years to divert the sewage from the proposed outlet to another place of disposal, and the diversion of the sewage can be effected more economically if the sewers are constructed upon the separate plan. Surface water and ground drainage, if unmixed with sewage, can be allowed to discharge into the river at convenient points without objection.

FALL RIVER.

MARCH 2, 1911.

To the Hon. THOMAS J. HIGGINS, *Mayor of the City of Fall River.*

DEAR SIR: — The State Board of Health has considered the application of the city of Fall River for advice as to the location of a proposed sewer and outlet to discharge the sewage of a district in the northerly part of the city into the Taunton River at a point about half a mile below the mouth of Steep Brook, and in response to this application has caused the locality to be examined by one of its engineers and has considered the plan presented.

It appears that this proposed outlet is a part of a combined system of sewerage designed for the city many years ago. The district to be served by this outlet has an area of about 0.8 of a square mile lying south of Wilson Road and including a large portion of the watershed of Steep Brook. At the present time this area is not thickly populated, and the quantity of sewage that will be discharged from this district is likely to be small for many years in the future. It is proposed to locate the outlet at the shore at high water at a point quite remote from dwelling houses, there being but one building within several hundred feet of the proposed outlet.

While it is probable, in the opinion of the Board, that the sewage from the district in question could be discharged at this outlet without very serious objection for a number of years in the future, the outlet is likely to become increasingly objectionable as the population in this district increases. Objectionable conditions can be avoided by conveying the sewage in a pipe laid beneath the river bottom to a point located at a sufficient distance from the shore to prevent the sewage from being returned upon it before it has become thoroughly diluted with the water; and the Board recommends that when this outlet is constructed provision be made for an extension which will discharge the dry-weather flow of sewage at a point in the river well away from the shore. If this plan is followed, the mingled sewage and surface water flowing from the sewer at times of storm can be allowed to discharge at the outlet near the shore, as now proposed, probably for a long time in the future, without creating objectionable conditions.

It appears that the separate system of sewerage is being employed in portions of the city where that system can be used to advantage, and it is not improbable that in the district to be served by the sewer now under consideration, it may be found of advantage to adopt the separate system in at least a part of the area, utilizing the local water courses for the removal of storm water. The use of the local water courses in this area for this purpose would probably not be objectionable if sewage is kept strictly out of the storm-water drains.

The conditions at several of the main sewer outlets in the city of Fall River are very objectionable at the present time on account of the fouling of the shores in their neighborhood with matters deposited from the sewage. There is no reason to doubt that the conditions at these outlets could be greatly improved if the dry-weather flow of sewage should be carried out into the river through a suitable pipe laid beneath the bottom of the river and discharging at such distances from shore that the sewage would become thoroughly mingled with the water before it could return. The Board recommends that an investigation be made and plans prepared for the improvement of these outlets, and that the work be taken up as soon as practicable.

FOXBOROUGH (STATE HOSPITAL).

DEC. 7, 1911.

To the Board of Trustees of the Foxborough State Hospital.

GENTLEMEN: — The State Board of Health received from you, through your engineer, on Nov. 24, 1911, an application for advice as to a proposed source of water supply and a system of sewage disposal for the buildings which it is proposed to construct for the purposes of the institution during the coming year upon lands recently acquired in Norfolk and Walpole.

It appears that the proposed buildings will probably accommodate not more than 100 persons, and that laundry work will not be done at this institution in the beginning, but it is expected that later on other buildings will be added and that, in consequence, the quantity of water required for the water supply of the institution and the quantity of sewage to be disposed of will increase materially in the future.

The application and plans presented provide for taking a supply of water for the institution from a well to be located on the site of the Fales Spring, so called, located about 300 feet northwest of the State highway between Walpole and Wrentham and about 1,100 feet northeast of the house now or formerly of N. H. Fales. For the disposal of the sewage it is proposed to construct filter beds without underdrains having an aggregate area of about one-fourth of an acre, the works to be located about 350 feet southeast of the State road and 700 feet from the Fales house mentioned above.

The Board has caused the location of the proposed source of water supply to be examined by its engineer and a sample of the water from the small pond at the site of the spring to be analyzed. The results of the analysis show that the water flowing from the spring at the present time is of good quality for all the purposes of a public water supply.

Regarding the quantity of water obtainable from the proposed supply no definite estimate can yet be made, but judging from the flow of the spring at the present time it is probable that a sufficient quantity of water can be obtained by the proposed plan for all the requirements of the buildings represented on the plan. If necessary in the future, it is probable that a large additional supply can be obtained from wells or other suitable collecting works near the foot of the high land north of the proposed well, and in the location of future buildings or other works upon these grounds the possibility of the extension of the water works in that direction should be taken into account.

The locality of the proposed sewage filter beds has also been examined under the direction of the Board, and this location is, in its opinion, a suitable one for the disposal of the sewage of the main buildings of the institution as now planned. The soil at the location of the filters appears to be coarse and porous, and it is probable that the limited quantity of sewage likely to reach the filters in the beginning can be disposed of satisfactorily without underdrainage; but it is very important that adequate underdrainage be provided as soon as it is found to be necessary, and it is advisable to provide main underdrains in the beginning. The filters are so located that it is unlikely that their presence will ever be noticeable at the State highway or at any dwelling house in the neighborhood, and the location selected is an appropriate one for the disposal of the sewage of the institution as proposed.

FRAMINGHAM.

FEB. 2, 1911.

To the Committee on Sewerage, Framingham, Mass., FRANK W. PATCH, M.D., *Chairman.*

GENTLEMEN: — The State Board of Health received from you on Jan. 25, 1911, an application for advice as to a proposed system of sewerage for the village of Framingham Center, accompanied by plans and a report by your engineer describing the proposed system.

The plans provide for collecting the sewage of the thickly settled portions of the village of Framingham Center in a system of pipe sewers and conveying it to a pumping station and reservoirs to be located on the easterly bank of the Sudbury River, southeast of the village, whence it is to be pumped to the present filtration area and purified by intermittent filtration. The total length of the sewers, as shown upon the plan presented, is about 8.5 miles, and the plan provides for intercepting the sewage from the Normal School, which is now discharged upon a small filtration area near State Street, from which much unpurified sewage flows over the ground to the Sudbury River, and disposing of it in connection with the sewage of the other portions of the town. At the pumping station a reservoir, having a capacity of about 330,000 gallons, is to be constructed, to hold the night flow of sewage, so as to make it practicable to do the pumping in the daytime. From the pumping station the sewage is to be pumped through a 12-inch forcemain to a connection with the existing 12-inch forcemain from the present pumping station, at the point where it enters Hartford Street, and a new forcemain 18 inches in diameter is to be laid from this point to the filtration area to replace the portion of the existing 12-inch forcemain which is to be made a part of the Framingham Center system, thus reducing the cost of pumping the sewage at the present pumping station.

The Board has examined the plans presented and concludes that the proposed plan is an appropriate one for the collection and disposal of the sewage of Framingham Center. The area of filter beds already constructed by the town for the disposal of its sewage is probably sufficient for the purification of all of the sewage of South Framingham and also for that which may be discharged upon it from the Framingham Center system for a time at least; but it will probably be necessary to construct additional filter beds within a short time after the general introduction of sewers in the village of Framingham Center.

GARDNER.

JUNE 1, 1911.

To the Board of Sewer Commissioners of the Town of Gardner, MR. GEORGE N. DYER, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on April 30, 1911, a communication stating that the filter beds built by the town in 1909 have failed to give satisfaction and that an investigation is to be made to determine the condition of the underdrains, and at the same time you request advice as to the improvement of the works.

Subsequently underdrains were opened in two of the filters constructed in 1909 and their condition has been examined by the chemist and one of the engineers of the Board. An examination of two underdrains, one in bed No. 14 and one in bed No. 21, has shown that in some places the joints of the pipes were completely filled with a growth of organisms, while in other places the openings between the pipes, though free from organic growths, were filled with sand.

It appears from these examinations that these underdrains were covered with fine material at the time of their construction and that very little gravel was placed about them, — in some places gravel being practically absent.

Attempts were made at various other places in these beds to uncover the underdrains, but it was found that the beds were saturated with sewage to within one or two feet of the surface of the sand, and the soil in many places was black, indicating that the beds had remained saturated for long periods, to the exclusion of air, a condition probably caused by clogging of the underdrains.

It is evident from this examination that the inefficient results obtained in the treatment of sewage at this filtration area are due in part to the clogging of the underdrains, and the Board recommends that the underdrains in the filters constructed in 1909 be examined and relaid where necessary. In relaying the underdrains care should be taken to provide an ample quantity of gravel properly graded about the joints of the pipes to allow the effluent to enter freely and prevent the entrance of sand.

Observations of the flow of sewage from the Gardner sewers show very great variations, the maximum amount probably exceeding 1,500,000 gallons per day, while in dry months the average is less than 400,000 gallons per day. A part of this sewage is treated upon the old filter beds in Gardner, which have an available area of about two acres and have successfully purified large quantities of sewage for many years except when overdosed. The filter beds in Templeton, including the filters constructed in 1909, have an aggregate area of 10 acres, making the total filtering area available to the town about 12 acres. The quantity of sewage delivered at the filter beds has amounted at times to as much as 1,300,000 gallons per day or more for many days, — a quantity of sewage much greater than the filters would be capable of purifying even if the underdrains were in satisfactory condition and the filters were properly operated.

It is evident from the measurements of the flow of sewage that a very large quantity of water finds its way into the sewers, and it is probable that by a careful investigation it would be found practicable to reduce materially the leakage into the sewers and thus reduce the quantity of sewage to be treated, possibly within limits that could be successfully purified upon the area of filter beds now in use.

The available records of the flow of sewage at this area indicate that the average rate at which sewage would be applied, if the entire area were properly operated, would be somewhat less than 70,000 gallons per acre per day, but it has been the custom to apply the entire daily flow of sewage to two or three acres, making the actual rate of operation about 200,000 gallons per acre per day on the area used. Experience has shown that satisfactory results cannot be expected with this method of operation, and it is essential that the method of applying the sewage to the filter beds be changed. The Board recommends that the sewage be evenly distributed to the entire area each day, except of course to such beds as are out of use for cleaning or repairs, and the discharge of an excessive quantity of sewage upon any bed should be avoided at all times.

It is also necessary to prepare the surfaces of the filter beds in the fall by ridging and trenching, in such a way that the sewage can be applied beneath the snow and ice in winter and thus keep the filters in successful operation.

It appears that the settling tank, through which the sewage is passed before reaching the filters, has been emptied very infrequently and that it has contained for a long period a large accumulation of sludge. The settling tank should be cleaned out and should hereafter be emptied and the sludge wholly removed as often as once a week, if this tank is to be continued in use. The operation of this tank will require considerable care, and it is not improbable that more satisfactory results will be obtained by the use of one or two of the compartments only and by discontinuing the use of the others. If necessary, additional sludge beds should be provided for receiving and drying the sludge from this tank.

HARDWICK (GILBERTVILLE).

JULY 6, 1911.

To the George H. Gilbert Manufacturing Company, Hardwick, Mass.

GENTLEMEN: — The State Board of Health received from you on June 24, 1911, an application for advice as to a proposed system of sewerage for the village of Gilbertville in the town of Hardwick, accompanied by a plan showing the proposed main sewers and outlet. The plan provides for a system of main sewers in that portion of the village northwest of the Ware River, to be constructed on the separate plan, excluding surface water and ground drainage so far as practicable, and it is proposed to dispose of the sewage by discharging it into the channel of the Ware River below the lower dam in the village.

In response to this application, the Board has caused the locality to be examined by one of its engineers and has considered the plan presented and the information available as to the condition of the Ware River in Gilbertville and below. From this examination it appears that at the point at which it is proposed to discharge the sewage below the lower dam there is little or no flow in the river in the drier portion of the year, and when visited recently there was no water flowing over the dam and the manufacturing wastes, which are now discharged at this point through a pipe from the upper mill, had accumulated at the foot of the dam in a large pool and were finding their way slowly down the stream among the rocks with which the bed of the river is covered. Under these circumstances, if the proposed sewer outlet were located at the point indicated, sewage would be likely to collect in pools among the rocks, in which solid matters from the sewage would accumulate and cause a nuisance. In order to avoid danger of a very serious nuisance from the discharge of sewage into the river, it will be necessary to extend the outlet down-stream at least to a point near the lower end of mill No. 4, where the sewage will mingle with a considerable quantity of water discharged from the engine room at a point above and will subsequently be diluted a short distance below by the whole dry-weather flow of the river when the mills are in operation or water is passing the dam.

The quantity of sewage that would be collected by the proposed system of sewerage, even if extended to serve all portions of the village, would not be large in proportion to the dry-weather flow of the Ware River, but the river is already polluted to a very considerable extent by sewage and manufacturing wastes discharged at points above Gilbertville and receives large additional quantities of polluting matter in Gilbertville and subsequently at Ware, and the condition of this river has become objectionable.

Under these circumstances it is not probable, in the opinion of the Board, that the Ware River can be used as a permanent outlet for the sewage of Gilbertville at any point. It is probable that it will be permissible to discharge the sewage of the village into the stream temporarily and possibly to continue the discharge for a period of two or three years after the works are first put in operation.

The best plan of disposing of the sewage of the village will probably be to purify it on filter beds of sand or gravel, if an area suitable for this purpose can be found in the valley of the river within reasonable distance below the village. The Board recommends that in the preparation of further plans for the disposal of the sewage of the town you investigate the best plan of disposing of the sewage and select a location for the disposal works so that means for the proper disposal of the sewage can be provided whenever its removal from the stream becomes necessary. A temporary outlet for the sewage should then be selected at some point in the neighborhood of, or below, the lower mill, where the sewage will be well diluted and carried quickly to the current of the main stream below the raceway, but the works should be so designed that the sewage can be diverted to the disposal area whenever necessary with as little change as practicable.

It may be of advantage to discharge some of the manufacturing wastes from the mills into the sewers and provide for their purification in connection with the sewage at the disposal works, but wool-scouring waste must be treated for the removal of grease before it can be purified by ordinary methods.

When you have prepared further plans for the disposal of the sewage, including, if desired, such manufacturing wastes as may reasonably be disposed of in connection with the sewage, the Board will, upon application, give you further advice as to the disposal of the sewage of the village.

HUDSON.

MARCH 2, 1911.

To the Board of Public Works of the Town of Hudson, Mr. GEORGE P. KEITH, *Chairman.*

GENTLEMEN: — In accordance with your request of Feb. 16, 1911, for advice as to the advisability of admitting the effluent from a process known as "back washing" at the works of the Hudson Combing Company's plant, located just east of the sewage pumping station of the town of Hudson, into the Hudson sewers, the Board has caused the works to be examined and samples of the effluent to be analyzed.

It appears from the information that has been collected by the Board that the quantity of this waste is likely to amount at the present time to about 500 gallons per day.. Judging from the wastes discharged from the back-washing machines at the Hudson Worsted Company's plant, which are similar to those to be installed at the proposed new works, it is probable that the effluent from the process of back washing will contain from 2 to 2½ parts per 100,000 of albuminoid ammonia and from 50 to somewhat more than 100 parts of fats. Considering the condition of the sewage disposal works, the effluent discharged therefrom and the quality of the sewage now discharged at those works, it seems to the Board probable that the wastes from back washing at the proposed works can be admitted to the Hudson sewers without objection, provided the quantity shall not exceed 1,000 gallons per day in any day, and that the quantity of organic matter, as shown by the albuminoid ammonia, shall not exceed 3 parts per 100,000 and the quantity of fats 150 parts per 100,000. It will be desirable to discharge these wastes into the sewers at different times through the day, in order to insure dilution of the wastes by the sewage before it reaches the filter beds.

LANCASTER (STATE INDUSTRIAL SCHOOL).

NOV. 8, 1911.

To the Trustees of the Massachusetts Training Schools, MRS. ELIZABETH G. EVANS, *Secretary, 12 Otis Place, Boston Mass.*

LADIES AND GENTLEMEN: — The State Board of Health received from you on Oct. 17, 1911, plans for a system of sewage disposal for the State Industrial School at Lancaster, which in detail are much the same as those already adopted but which provide for a change in the location of the filter beds.

The plans now presented provide for collecting the sewage of all of the buildings, including the laundry and bakery, which are not at present connected with the sewerage system, in a tank to be located about 450 feet north of the nearest institution building and 250 feet south of the Bolton road, from which the sewage is to be discharged through about 1,150 feet of cast iron pipe to filter beds to be constructed north of the Bolton road on the westerly side of a small brook which discharges into the Nashua River, a little over half a mile below the junction of the north and south branches. The tank in which the sewage is to be collected will be divided, according to the plans, into two portions, — a settling tank having a capacity of about 3,600 gallons and a dosing tank with a capacity of about 9,600 gallons. It is not the intention, however, to discharge the sludge from the settling tank upon ground in the neighborhood of the tank, the plans providing for flushing the contents of the settling tank to the filter beds when desirable by discharging the contents of the dosing tank through the settling tank. The plans, like those submitted at an earlier date, provide for the connection of a water pipe with the main sewer near the settling tank, so that the pressure of the water works system may be used to flush the sewer in case of need.

The filter beds shown on the plans are located about 850 feet north of the Bolton road, about 50 feet west of the brook referred to above, and with the exception of a group of buildings about 600 feet east of the filters, there are no buildings within a long distance. Six filter beds are indicated on the plans having an aggregate area of about 30,000 square feet, or approximately 0.7 of an acre, but two of the beds are shown in dotted lines, indicating presumably that only four of the filters, having an aggregate area of 20,000 square feet, are to be constructed in the beginning. It is proposed to construct the filter beds of material taken from a gravel bank on land owned by the Commonwealth, about three-quarters of a mile east of the proposed location of the filters.

The Board has caused the locality to be examined by one of its engineers and has considered the plans presented. The location of the filter beds is at such a distance from buildings that with proper care it is unlikely that they would be objectionable. If trees and shrubs should be planted around the filters, the danger that odors from them would be noticeable in the neighborhood would be diminished.

It appears that the population of the institution has increased nearly 50 per cent. since the plans previously approved were submitted, and in the opinion of the Board, it is necessary to construct the whole area of filter beds indicated on the plans, in order to provide adequately for the purification of the sewage of the institution at the present time. Moreover, no bed is shown for the disposal of the sludge which will collect in the sludge tank, and this sludge is presumably to be discharged upon one of the filter beds. The disposal of sludge is one of the most serious causes of objectionable odors from sewage-disposal areas, and under the existing circumstances it will be better, in the opinion of the Board, to eliminate the sludge tank and discharge the sewage after screening directly upon the filter beds. In order to insure satisfactory purification of the sewage at all times under these conditions, an extra filter bed of the same area as those indicated on the general plan should be provided. It is very important that the underdrains be laid with care and surrounded and covered with graded gravel. The depth of the filtering material should be at least 4½ feet above the underdrains.

An examination of the gravel bank from which it is proposed to take the material for the construction of the filter beds shows that much of it is of good quality for sewage purification purposes, but in some places the material is very fine and unsuitable, and great care will have to be exercised in the selection of the material used in the construction of the filter beds if successful results are to be obtained.

With the modifications suggested and if the works are properly constructed, they will, in the opinion of the Board, provide adequately for the disposal of all the sewage of the institution while its population is no greater than at the present time.

LEXINGTON.

FEB. 2, 1911.

To the Board of Water and Sewer Commissioners of the Town of Lexington.

GENTLEMEN: — The State Board of Health received from you on Nov. 23, 1910, the following application for advice as to whether it is best for the town to undertake the lowering of the brooks in Lexington for the purpose of securing better drainage and postponing the construction of a system of sewerage: —

> As you know, the town of Lexington is still without any system of sewers. The project to construct a system meets with opposition for various reasons. Among them is the belief entertained by some that the lowering of Vine Brook and possibly also the brook that runs northeasterly through the meadow in the rear of the Unitarian Church, thence across Bedford Street and the railroad and thence northerly toward North Lexington, would through the consequent lowering of the ground water so improve the drainage of cesspools and otherwise relieve the situation as to make it unnecessary for the Town to install a sewerage system for a number of years to come.
>
> It is upon this question that our Board respectfully solicits your advice. We should be glad to have you inform us as to the bearing which any practicable scheme of lowering these or any other brooks in the town may have upon the question of disposing of sewage matter through a system of sewers designed exclusively therefor, and advise the Town whether it had best as a first step undertake the lowering of the brook or brooks or the construction of a sewerage system.

In response to the application the Board has caused the locality to be examined by one of its engineers and has caused the elevation of the water at various points in the brooks about the town and of the sewage in many cesspools in various parts of the village to be determined. A comparison of the elevations of a number of cesspools located very close to Vine Brook along the easterly side of the village shows that the sewage in the cesspools within short distances of the brook stands at elevations several feet higher than the level of the brook. Along the westerly side of the town, at the head waters of certain tributaries of Kiln Brook, so called, in the low ground west of Bedford Street, the sewage in the cesspools near the level of the meadow stands but little above the level of the water in the tributaries of the brook, but a short distance back from the brook the sewage stands in some cases several feet higher than the level of the water in the ditches. East of Bedford Street the sewage stands in several places at a very high level, as compared with the streams. In the central portion of the town the sewage in the cesspools, even very close to the brooks and channels, stands in practically all cases several feet above the level of the water in these streams.

Notwithstanding the fact that the rainfall has been much less than the average for a long period and the level of the ground water probably considerably lower than usual, some of the cesspools overflow upon the ground about them or into neighboring streams and drains, and the condition of many of the cesspools is objectionable.

If the soil of the territory upon which the village is located were composed of coarse sand or gravel, it is probable that by lowering the brooks the contents of the cesspools would for a time filter through the ground to the streams so freely that overflows from cesspools or the necessity of frequently cleaning them would be avoided, though in time, with constant use, the soil about the cesspools would tend to become clogged with sewage matter and the sewage would be absorbed less readily; but the investigations of the Board indicate that the soil beneath much of the village is not of such a character as to allow sewage to pass freely, and under these conditions it is improbable, in the opinion of the Board, that the lowering of the brooks suggested in your communication would afford material relief from the conditions now existing in the thickly populated part of the town.

In earlier years, before the modern system of sewerage had come into general use, the construction of a drainage system sometimes preceded sewerage, and in such cases it frequently happened that sink drains and overflows from cesspools or other receptacles for sewage were connected with the drainage system, with the result that local water courses became very seriously polluted thereby. Under the conditions existing in Lexington, judging from the information available to the Board, it will be impracticable to prevent the pollution of the streams by sewage if the plan of constructing a drainage system in the beginning is adopted and the construction of sewers postponed to some future time. The brooks and streams in and about the village should be deepened or otherwise improved wherever necessary, in order that they may serve adequately for ground drainage and the removal of surface water at times of storms. Such use of the local waters is a reasonable and proper one, but sewage should be kept wholly out of them.

APRIL 25, 1911.

To the Board of Water and Sewer Commissioners of the Town of Lexington,
Messrs. ROBERT P. CLAPP, FRANCIS W. DEAN and DWIGHT F. KILGOUR.

GENTLEMEN: — The State Board of Health received from you on March 28, 1911, the following communication requesting its approval under the provisions of chapter 504 of the Acts of the year 1897, as amended by chapter 359 of the Acts of the year 1906 and chapter 201 of the Acts of the year 1911, of certain changes in the location, grades and sizes of the main and intercepting sewers of the town of Lexington, as approved by the Board on April 16, 1898, and Feb. 14, 1907: —

> The undersigned, being the board of water and sewer commissioners of the town of Lexington, respectfully show as follows: —
>
> The question of introducing a sewerage system in Lexington will soon be brought again before the town for action.
>
> We recommend and propose the adoption of substantially the system which your Board has heretofore approved, and after the necessary action by the town shall have been taken, we shall proceed with the work of construction agreeably to the requirements expressed in your communication of April 16, 1898, as modified by that of Feb. 14, 1907, addressed to the board of sewer commissioners of Lexington; except that, acting under the authority of the act just passed by the Legislature (chapter 201 of the Acts of 1911), we shall make certain changes in the location, grades and sizes of the main and intercepting sewers. The sewer that is to begin near the base of Granny Hill and run thence to Woburn Street, though retaining substantially its original lay-out as far as the latter point, will there depart from the line heretofore proposed and approved, and (instead of running across a corner of the Munroe meadow to the railroad location and thence in and near the railroad to Curve or Flint Street) will extend through the meadow and around the hill near Pierce's Bridge Station, and thence run in or near the railroad location as far as Bow Street, where it will turn into Massachusetts Avenue about 734 feet from the Arlington town line. This change will altogether exempt from use as a main sewer carrying sewage from the central part of

the town the pipe in Massachusetts Avenue from Curve or Flint Street to Bow Street, and consequently said section of pipe will not be laid at a lower level than may be necessary in order to make it serve the local demands upon it.

Plans and profiles showing the changed location, grades and sizes which we intend to adopt are submitted herewith as a part of this petition; and we respectfully ask your approval of the same, with authority to make such minor departures therefrom, not substantially affecting the general route of the main and intercepting sewers, as may be suggested by unexpected obstacles encountered in the actual work of laying out and constructing the same. And we request such further authority and instructions in the premises as to your Honorable Board may seem best.

By the proposed plan the location of the main sewer beginning near the base of Granny Hill in the valley of Vine Brook and extending to a connection with the metropolitan sewer in Massachusetts Avenue at the Arlington town boundary will be changed, and the new sewer will be located along a more easterly line varying from a few feet to about a quarter of a mile east of the location formerly approved. The new sewer will pass for a considerable portion of its length through the watershed of the Arlington Reservoir.

Upon receipt of your application the State Board of Health gave a hearing at its office on Thursday, April 6, 1911, after notice to the board of water commissioners of the town of Arlington, as required by the provisions of chapter 504 of the Acts of the year 1897, and at this hearing plans showing in detail the proposed changes in the system of sewerage were presented by your board, and the town of Arlington was represented by its town counsel.

After this hearing, the Board, having caused the locality to be examined by its engineer, and having considered the plans and information presented at the hearing, voted to approve the proposed modification in the sewerage system of the town of Lexington and the plans thereof presented, as shown upon a plan and a profile accompanying said application, entitled, respectively: —

Proposed Outlet Sewer, Lexington, Mass., from the Metropolitan Sewer to foot of Granny Hill.
Horizontal scale 250 feet to an inch.
Vertical " 10 " " " "
Feb. 4, 1911.
McClintock & Woodfall, Consulting and Civil Engineers, 15 Court Sq., Boston.
and

Profile of the Proposed Sewer in Massachusetts Ave. from the Arlington Line to Curve St. and a part of Curve St. on line of Outlet Sewer, as proposed in 1897. Lexington, Mass. March 28, 1911. McClintock & Woodfall, Consulting and Civil Engineers, 15 Court Sq., Boston, Mass.

It appearing that the water of the Arlington Reservoir has not been used or supplied by that town for domestic purposes for several years, the Board continues the suspension of certain requirements in building the sewers in the watershed of the Arlington Reservoir, as approved in the communication of Feb. 14, 1907, for such further period as the water of the reservoir may remain unused as at present, provided that the town of Lexington in contracting for the construction of its sewer shall cause to be inserted in its contracts such provisions as are usual or necessary to secure proper sanitary conditions on or about the work and prevent the pollution of local waters.

It appears from the examination of the territory and from the information presented that the new main sewer line where it passes through the watershed of Arlington Reservoir below Vine Street will probably be laid below the level of the ground water and in territory where the soil is for the most part coarse and porous. In the remainder of its course also nearly to the Arlington boundary the sewer will be for the most part below the level of the ground water, and great care will be necessary in the construction of this sewer in order to prevent excessive leakage.

In the opinion of the Board it will probably be best to build the main sewer below Vine Street of iron pipe with lead joints in order to prevent danger of excessive leakage into the sewer.

MARION.

DEC. 7, 1911.

To the Board of Sewer Commissioners, Marion, Mass.

GENTLEMEN: — A recent examination of the sewage disposal works of the town of Marion shows that four of the filter beds were at that time covered with sewage to a depth of from 1 to 2 feet, while sewage was standing in pools upon two of the others. It was also found that the sludge which has accumulated during the past year had not then been removed, and that the surfaces of the filter beds had not been prepared in such a way that they could be operated satisfactorily in the winter season.

The objectionable condition of these filter beds is due in part to the method of operation of the filters and in part to the excessive quantity of sewage discharged upon them, the average quantity pumped being apparently as high as 80,000 gallons per day, making necessary the operation of the filters at the rate of as much as 120,000 gallons per acre per day.

It will be difficult, if not impracticable, even with the best of care, to operate these filter beds satisfactorily at so high a rate, and unless the quantity of sewage can be materially reduced, it will be necessary to increase the size of the filtration area.

It is evident that the excessive flow of sewage at this area is due chiefly to leakage of water into the sewerage system, and it is not unlikely that a large part of this leakage can be prevented and the quantity of sewage requiring purification very materially reduced.

The Board recommends that an investigation be made without delay to determine the cause of the great leakage into the sewerage system, the location of the principal leaks and the practicability of reducing materially the quantity of sewage requiring purification by the prevention of leakage. If it is found impracticable to reduce the leakage materially, the Board recommends that the area of filter beds be increased sufficiently to make adequate provision for the purification of the sewage at all times.

In the operation of the filters it is essential that all of the filter beds be used, so far as practicable, every day, and that no more sewage be applied to them than will pass through the filters. The surfaces of the filters should be cleaned at frequent intervals and kept in proper condition for the efficient purification of sewage. The surfaces of the beds should be prepared each year, late in the autumn, with ridges and furrows, so that the sewage may be applied to the filters without interference from ice and snow in the cold weather.

When you have made the investigations herein suggested or have determined upon a plan for improving the efficiency of the disposal works, the Board will, if you so request, give you further advice as to the disposal of the sewage of the town.

MONSON (STATE HOSPITAL).

JAN. 5, 1911.

To EVERETT FLOOD, M.D., *Superintendent of the Monson State Hospital, Palmer, Mass.*

DEAR SIR: — The State Board of Health received from you on Sept. 6, 1910, an application stating that it is proposed to change the location of the filter beds for the disposal of the sewage of the hospital, as approved by this Board on Oct. 14, 1909, and submitting a plan showing the filter beds that it is now desired to construct, and you request the advice of the Board as to the proposed scheme. Subsequently, on

December 7, the plans of the proposed filter beds were submitted by your engineers, together with a description of the proposed works.

The plans now presented provide for collecting the sewage of the buildings, including buildings Nos. 1 and 2 of the farm group and the buildings of the children's colony, so called, and conveying it to a settling tank, screen chamber and dosing tank to be located at the southwesterly corner of the present filter beds, whence the sewage will be discharged upon three filter beds to be constructed on the east and southeast sides of the present filter beds instead of on their northwest side, as proposed in 1909. The proposed new filter beds are to have an aggregate area of 0.75 of an acre, or about three-quarters of that proposed in the former plan, and the depth of the filtering material, as shown upon the plans, is to be 2½ feet. The filters are to be quite thoroughly underdrained, the underdrains discharging upon a meadow, whence the effluent will find its way through an open channel to the Quaboag River. The soil of which the beds are to be constructed is composed apparently of sand and gravel beneath, in most places, a rather deep layer of soil and subsoil, and it is understood that you propose to construct the filters largely of sand and gravel to be hauled from the bank west of the present filter beds, where the material is of good quality for the purification of sewage.

The Board has caused the locality to be examined by one of its engineers and has considered the plans presented. The location now proposed for the additional filter beds is well removed from any dwelling houses or other buildings, and the sewage can be conveyed to the filters by gravity without difficulty.

The Board recommends that the proposed settling tank be omitted from the plan, and that the dosing tank, including the screens, which can be placed just above the tank, be located farther up the hill west of the filter beds, so that in future this tank and the screens can still be utilized in case it should be found necessary to construct additional filter beds at the northwesterly side of the present filters, as proposed in 1909. The use of a part of one of the present filters as a sludge bed would then be unnecessary and better results are likely to be obtained without the use of a settling tank, while by omitting it a considerable saving can be made in the cost of the works. The Board also recommends that the depth of filtering material be made not less than 4 feet over the main underdrains or less than 3½ feet at the ends of the lateral underdrains.

The area of filters which it is now proposed to construct is somewhat smaller than was proposed in the plan presented in 1909, but if the filters already built shall be thoroughly underdrained and the entire area utilized to the best advantage, it will probably be sufficient for the purification of the sewage at present discharged from the hospital. The proposed filters can be enlarged somewhat by utilizing all the area between the present and proposed filters, and this area should be included within the area of the proposed beds.

It is important that the wastes from the laundry, which have heretofore been discharged upon the ground west of the filter beds and allowed to flow over the surface to the meadow, shall be included with the sewage, since a recent analysis indicates that these wastes contain at times a larger quantity of organic matter than the sewage from the other buildings.

NATICK.

FEB. 27, 1911.

To the Board of Sewer Commissioners of the Town of Natick, Mr. P. F. HALLINAN, *Superintendent.*

GENTLEMEN: — The State Board of Health received from you on Feb. 7, 1911, the following communication requesting its opinion as to whether any marked improvement has been effected in the purification of the sewage of the town of Natick since attention was called to the unsatisfactory condition of the works early in 1908: —

> On April 13, 1908, the sewer commissioners of Natick received a complaint as to the unsatisfactory condition of its filtering system and that something must be done at once to relieve the nuisance. We have done what we thought was the very best thing that could be done to remedy the then existing condition. We now would like to know if in the opinion of your Board that any marked improvement has been made and to what extent.

The Board has considered the information available as to the improvements that have been made in the works during the last three years and the changes effected in their operation, and has examined the results of numerous analyses of the sewage and effluent. These results show that since early in 1908 there has been a great decrease in the quantity of iron and a reduction in the quantity of organic matter in the effluent discharged from these works, accompanied by a marked increase in the quantity of nitrates, these results indicating a great improvement in the efficiency of the filter beds. Examinations of the filter beds from time to time have shown that there has been a decided improvement in their appearance and general condition, and during the past year the sewage has disappeared readily from the surfaces of the beds and has been found standing for a considerable time upon only one of them during the past year, whereas in previous years the sewage accumulated upon the surfaces of the beds and gave off very offensive odors.

It appears from the information furnished the Board that the two main underdrains which extend through the middle of the two lines of filters have been taken up, relaid and surrounded with crushed stone of graded sizes, so as to admit the underdrainage and keep out the sand, and the efficiency of the beds has no doubt been greatly increased by the improvement effected in the underdrains. It further appears from such examinations as have been made of the lateral underdrains in each of the beds that they are to a large extent clogged and that the joints in these drains do not admit the underdrainage freely. It will be very difficult to secure continued satisfactory operation of these filters unless they are efficiently underdrained, and the Board recommends that during the coming year the lateral underdrains in each of the beds be carefully examined, and that wherever they are found to be clogged, the drains be relaid in gravel or broken stone, properly graded, as has been done with the main underdrain. Such work as may be required in improving the underdrainage of these filters should be begun as soon as possible and completed during the coming year. It will then be practicable to determine whether the filter beds are capable of purifying all of the sewage efficiently and satisfactorily at all times, or whether further improvements are necessary.

The observations of the flow of sewage in the Natick sewerage system indicate that a very large quantity of ground water leaks into the sewers, especially in wet periods when the ground water is high. During the recent dry years the quantity of ground water leaking into the sewers has been less than formerly, but it may be found desirable, in addition to the improvements at the filter beds, to reduce the flow of sewage by eliminating unnecessary leakage, and as soon as practicable observations should be made to determine the quantity of leakage into the various parts of the system and the practicability of reducing materially the flow of sewage by eliminating leakage from sections of the sewerage system where the quantity is found to be greatest.

The great improvement that has been effected in the condition of these filters since 1908 and in the efficiency of the purification of the sewage should be maintained, and the improvements above suggested continued until the works have been brought to the efficiency of which they are capable.

PALMER.

MAY 4, 1911.

To the Special Committee on Sewerage, Palmer, Mass., Mr. H. M. HOWE, *Chairman.*

GENTLEMEN: — The State Board of Health received from you on March 28, 1911, an application for advice relative to a proposed sewer for the accommodation of the inhabitants residing in that portion of

Palmer known as the Carpet Mill district, accompanied by a plan of the proposed sewer and by copies of votes of the town meeting relative thereto.

The plan presented provides for the construction of a sewer in Breckenridge Street and private lands from Pinney Street to the Quaboag River, where it is proposed to discharge the sewage into the stream at a point about 1,600 feet above the bridge of the Central Vermont Railroad and a mile up-stream from the nearest of the existing sewer outlets. The proposed sewer is to be 12 inches in diameter throughout, with a minimum grade of 0.40 per 100 and is to be constructed primarily for the removal of the manufacturing wastes from the works of the Palmer Carpet Company which are now discharged into the small brook which passes the works. The Board is informed that the quantity of these wastes amounts at present to about 10,000 gallons per day, consisting mainly of spent dye liquors and waste water from the washing of yarn, and that in addition to these wastes the sewer will receive the sewage from the carpet works, in which there are between 50 and 60 employees, and from three four-tenement blocks owned by the company. There are also, apparently, about five additional dwelling houses along the line of the proposed sewer.

The Board has caused the locality to be examined by one of its engineers and has considered the plan presented. The discharge of waste liquors into the small brook below the carpet works at present creates objectionable conditions in that stream, and sewerage facilities are badly needed at the dwelling houses in the neighborhood of the proposed sewer north of the Boston & Albany Railroad. While it would be practicable to dispose of the sewage from nearly all of the populated portion of the Carpet Mill district into the existing sewers, there appears to the Board one very serious objection to the plan of disposing of the sewage of this district at a separate outlet.

The quantity of sewage that would be discharged from the proposed sewer, taken in connection with the sewage discharged into the stream from other sources, would be unlikely to create objectionable conditions in the Quaboag River at the present time if the sewage were to be discharged in the stream in such a way that it would mingle quickly with the current; but the proposed sewer outlet shown upon the plan presented is located in a small cove, where there is little movement of the water, and objectionable conditions would very probably be created if the sewage should be discharged at this point. The Board recommends that the outlet be located 100 feet or more up-stream from the point proposed and that the pipe be carried out into the river to such a point that there will be at all times a width of several feet of flowing water between the outlet and the river bank.

With the change suggested in the outlet the Board is of the opinion that it will be permissible to dispose of the sewage from the sewer shown upon the plan presented by discharging it for the present into the Quaboag River without treatment, but this recommendation is made with the understanding that the sewage is to be removed from the river and purified whenever pollution of the stream makes such action necessary.

On account of the probable necessity of purifying the sewage at some future time, it is very important that all storm water, and, so far as practicable, ground drainage be kept out of the sewers from this and other districts in the town.

An examination of the existing sewer outlets discharging into the Quaboag River shows that these outlets are located at the edge of the stream, and at times, especially when the river is low in the summer season, the sewage collects along the river bank in the neighborhood of the outlets and creates objectionable conditions. These outlets could be greatly improved by extending the sewers to a point in the stream where the sewage would become quickly diluted by the water and the fouling of the banks of the river avoided.

PALMER (THREE RIVERS).

JUNE 12, 1911.

To Messrs. CHARLES S. RUGGLES and F. A. UPHAM, *Committee on Sewerage, Palmer, Mass.*

GENTLEMEN: — The State Board of Health received from you on May 13, 1911, an application for advice as to a proposed system of sewerage for the easterly portion of the village of Three Rivers, accompanied by a plan showing the location of the proposed sewers. The plan provides for extending the present sewer in East Main Street to a point east of Ruggles Street, and for constructing sewers in Ruggles, Pleasant, Charles, East Main, Oak and other streets, having an outlet into the Swift River about 1,700 feet above the confluence of the Swift and Quaboag rivers in the village of Three Rivers. It is understood that the sewers are to be constructed on the combined plan and are to remove both sewage and storm water from the area which they are designed to serve.

The Board has caused the locality to be examined by one of its engineers and has considered your application and the plan presented therewith. The quantity of water flowing in the Swift River at the proposed sewer outlet under present conditions is probably sufficient at all times for the proper dilution of the quantity of sewage likely to be discharged from the district in question, and if the outlet is properly constructed it appears to the Board permissible for the present to discharge this sewage into the river at the place proposed. The outlet should be located at some point where it will be at all times covered with water and at a sufficient distance from shore to prevent matters from the sewage returning upon the river bank in the immediate neighborhood.

In the construction of these sewers it is important to make provision, so far as practicable, for the probable necessity of removing the sewage from the river and purifying it, and under this condition it would be better to construct the sewers upon the separate plan in the beginning, collecting the storm water and sewage in separate pipes, since there is no objection to the discharge of storm water into the river at all times, while the expense of purifying the sewage will be greatly reduced if it is kept separate from the storm water. If it is found desirable in the present case to admit house sewage to the sewers, the house drains should be kept wholly separate from the roof leaders, and the works should be so designed that the house sewage may be intercepted at some future time with the least possible expense.

PLYMOUTH.

To the Board of Selectmen of the Town of Plymouth. APRIL 6, 1911.

GENTLEMEN: — The State Board of Health received from you on March 21, 1911, an application requesting its advice as to a proposed system of sewerage designed to collect the sewage from about 75 houses in the valley of a small brook crossing Sandwich Street about 250 feet south of Bay View Avenue, and discharge it at an outlet in Plymouth harbor 350 feet off Holmes' Point, and in response to this application the Board has caused the locality to be examined by one of its engineers.

The results of the examination show that in the southerly portion of Plymouth harbor in which this outlet will be located there are extensive areas of flats exposed at low water, and, in the opinion of the Board, the discharge of any considerable quantity of sewage into this portion of the harbor is likely to create a nuisance. The quantity of sewage to be discharged at the proposed outlet is not likely to be large, however, at least in the beginning, and it is probable that the outlet can be used temporarily without creating seriously objectionable conditions.

It appears to be practicable to intercept the sewage from the proposed outlet and from the Winter Street outlet, a short distance farther north, and convey the sewage from the areas served by these sewers to a connection with the main sewerage system of the town at or near Union Street, and, in the opinion of the Board, the outlet now used should be deemed to be temporary only and provision made so far as practicable at the time of its construction for disposing of the sewage eventually into the main sewerage system of the town. It is important that the sewers be constructed upon the separate plan, as proposed, and all storm water and, so far as practicable, all ground water, excluded from them.

SOUTHBRIDGE.

SEPT. 7, 1911.

To the Board of Sewer Commissioners, Southbridge, Mass., Mr. W. J. LAMOUREUX, *Clerk.*

GENTLEMEN: — The State Board of Health has considered your communication of Aug. 1, 1911, relative to odors from the filter beds of the Southbridge sewage disposal works, which you state are in excellent condition but from which an odor arises when the settling tanks are emptied, and has caused the locality to be examined by one of its engineers.

It appears from the information relative to the operation of the works that the settling tanks were emptied on May 31 and again on August 5, and that the odors complained of were most serious some time after the tanks were emptied in May. It also appears that at previous times complaints have been made to your board of the odors from the filter beds, which are believed to have been due to the sludge discharged from the settling tanks.

At the time the works were examined, a few days after the settling tanks had been emptied, sludge was drying upon the filter beds, and, though several days had elapsed since its discharge, the odor from it was quite strong at a considerable distance from the beds.

The only way of preventing objectionable odors from the sludge beds is to cover and mix the sludge with loam or some other suitable material soon after its discharge, and remove it to some suitable place of final disposal. It is probable that if the settling tanks were emptied with greater frequency, the odor of the sludge would be less objectionable, and if possible the tanks should be emptied at least as often as once in two weeks. It would be practicable during the warmer portion of the year at least to avoid the use of the settling tanks and discharge all of the sewage as it comes directly upon the filter beds, and in this way, if the sewage is properly distributed and the beds kept clean, objectionable odors from the sludge can be avoided; but so long as the sludge beds are used, the only way in which odors from them can be prevented is by the prompt removal of the sludge after discharge.

SPRINGFIELD.

Nov. 2, 1911.

To the Board of Public Works of the City of Springfield, Mr. CHARLES M. SLOCUM, *Clerk.*

GENTLEMEN: — The State Board of Health received from you on Sept. 27, 1911, an application for its advice relative to a proposed sewerage system for a district which it is now proposed to develop in the northeasterly part of the city, accompanied by a plan of the district and profile of a portion of the proposed main sewer with an outlet into the Chicopee River, about one and three-fourths miles above Chicopee Falls. According to the plan the district in question lies approximately between Carew Street on the northwest, St. James Avenue and St. James Circle on the west, the Boston & Albany Railroad on the south and extending presumably to the limits of the Poor Brook watershed on the east, though the eastern limits of the district are not indicated definitely on the plan submitted. It appears that with the exception of a few factory buildings on the northerly side of the Athol Branch of the Boston & Albany Railroad, near its junction with the main line, and a very small number of dwelling houses, the district is uninhabited at the present time, but it is expected that the population will increase quite rapidly in the future at the westerly end of the district, and the recent construction of a new railroad station on the Athol Branch railroad may cause an increase in population in its easterly portion.

The Board has caused the locality to be examined by one of its engineers and has considered the plans presented. The Board has also considered the condition of the Chicopee River and the results of recent examinations of that stream, including numerous analyses of the waters of the main stream and its tributaries. The examinations of the Chicopee River show that this stream is already considerably polluted by sewage and manufacturing wastes from the towns and villages within its watershed, and while the additional pollution that would be caused by the discharge of the sewage of the district in question into the river would be small in the beginning at least, it is not probable that the river could be used without objection as the permanent place of disposal for the sewage.

It appears from a further plan presented by your department that sewage from the westerly parts of the area in question in which sewerage is likely soonest to be required can be diverted by gravity without special difficulty into the Garden Brook sewer and discharged through the outlet of that sewer into the Connecticut River. The Garden Brook sewer receives both sewage and storm water, and the increase in the flow of this sewer that would be caused by the addition of the sewage from the area under consideration, east of St. James Avenue, would diminish somewhat its capacity for the removal of sewage and storm water from the area which it is designed to drain; but if the sewers in the area east of St. James Avenue are constructed strictly on the separate plan, as proposed, and surface and roof water, and, so far as possible, ground drainage, are excluded, the diversion of the sewage proper from the area in question into the Garden Brook sewer will in the beginning diminish but slightly its capacity for serving the district for which it is designed. If, with the growth of the city, the extension of the streets and the addition of buildings draining to the sewers, the Garden Brook sewer should require relief at some future time, the addition of the quantity of sewage likely to be discharged from the area in question in the northeasterly part of the city would not affect materially the problem of sewerage and drainage in the Garden Brook district. While the disposal of the sewage of the portions of the district farther east, especially in the valley of Poor Brook, cannot be effected by gravity in connection with any of the existing sewers of the city of Springfield draining toward the Connecticut River, it seems probable nevertheless that the most appropriate plan of disposing of the sewage of these areas would be to pump it over the divide into the Garden Brook sewer or some other of the sewers of the city discharging into the Connecticut River.

A further study of the question seems desirable before it will be practicable to decide definitely as to the best practicable plan for the removal of the sewage from this portion of the district, and as there is at present little or no population on the lands near Poor Brook there appears to be ample opportunity for the further study of the question of sewerage in this portion of the district. It appears to the Board very important that the sewers of the district in question east of St. James Avenue should be constructed strictly on the separate plan, as you propose, and that all surface and roof water, and, so far as practicable, all ground drainage should be excluded from the sewers in this district. The surface water and ground drainage, if unpolluted by sewage, can be discharged into the nearest water courses without objection.

The Board recommends that, so far as practicable, all the sewage of the district that can be diverted into the existing sewers of the city by gravity be discharged into those sewers, and for the disposal of the sewage of the remainder of the district, the Board recommends that a further study be made, especially with a view to pumping the sewage into one of the sewers discharging into the Connecticut River. When you have prepared further plans for the sewerage of the district or any portion thereof, the Board will give you further advice concerning them, if you so request.

STOUGHTON.

DEC. 4, 1911.

To the Sewerage Committee of the Town of Stoughton, MR. J. E. TALBOT, *Secretary.*

GENTLEMEN: — The State Board of Health received from you on July 27, 1911, the following communication requesting its advice relative to a proposed system of sewerage and sewage disposal for the town of Stoughton, accompanied by the report and plans therein mentioned: —

> Respectfully represents the town of Stoughton, by George H. Goward, J. Elmer Talbot, James E. Reilly, Frank A. Noyes, Cornelius Sullivan, Frank I. Capen, Harry C. Southworth, Charles S. Porter and Edgar F. Leonard, its committee duly elected;
>
> That a plan for a system of sewerage for said town of Stoughton has heretofore been presented to and duly approved by said Board.
>
> That said town is not ready at this time to adopt and construct according to said plan, because of its extended area and remote location of treatment works and consequent cost.
>
> That said town is ready to adopt and construct according to a plan of drainage that will at the present time provide for sewerage and manufacturing wastes from the factories in the center of the town, the sewerage of the center of the town, and prevent pollution of any tributaries of the Neponset River.
>
> And for the purpose of arriving at a practicable plan on the lines suggested, your petitioner herewith submits a report, marked "D," and plans, marked "A," "B," and "C," for the consideration of said Board, and respectfully asks the advice, approval, or recommendation of your Honorable Board in relation to the same; and that the secretary of the Board will give notice when the said committee may meet said Board, or a representative, in consultation in the matter.

Subsequently, in accordance with your request, members of the Board conferred with your committee and the engineer who prepared the plans relative to the proposed system of sewerage and the plan of location of the proposed disposal works.

The proposed system of sewerage is in most respects the system proposed by the Massachusetts Drainage Commission in its report of 1886. It provides for collecting the sewage in a system of pipe sewers and conveying it to a place of disposal near the junction of two small brooks about half a mile southwest of the center of the main village. At this place the sewage is to be passed through a septic tank and discharged upon filters having an area of a little over half an acre, which, it is stated, may be duplicated so as to increase the area to a little over an acre. It is also proposed to treat the entire flow of the brook in addition to the treatment of the sewage.

The Board has caused the location of the proposed disposal works to be examined and has considered the plans presented. If a separate system of sewerage is installed and house sewage from the densely populated districts, including manufacturing waste, is discharged into the sewers, all surface water and ground drainage, if unmixed with sewage, can be discharged directly into the streams and local water courses at the most convenient points, and it will be unnecessary to treat in any way the waters of the streams which drain the thickly settled parts of the town, as proposed in the plan presented.

At the conference with your committee it appeared that the claim had been made that the proposed disposal works were to be similar to those now in use at Hudson and Hopedale. The population of the town of Hudson, according to the census of 1910, was not very different from that of the town of Stoughton, the population of the former being 6,743 and of the latter 6,316. The quantity of manufacturing wastes that would be discharged into the sewers in Stoughton would probably not differ greatly from the amount at present discharged into the sewers at Hudson, and the total quantity of sewage that would require disposal from Stoughton after the sewerage system has come into general use would probably be much the same as that requiring disposal from the town of Hudson, the amount depending largely upon the care used in the construction of the sewerage system. The works that have been provided for the disposal of the sewage of the town of Hudson comprise nine acres of filter beds, while the works proposed in the plans now submitted for the disposal of the sewage of the town of Stoughton comprise at the most but very little over one acre. At Hopedale, where the population in 1910 was 2,188, or about one-third that of the town of Stoughton, the area of filter beds provided for the disposal of the sewage is 3¼ acres, or about three times the area proposed for the disposal of the sewage of the town of Stoughton in the plans presented.

The location of the proposed sewage disposal works is considerably nearer the village than that suggested by the Massachusetts Drainage Commission in 1886, which was thought at that time to be nearer the village than desirable, and an examination of the locality shows that there are about 125 dwelling houses which would be within one-quarter of a mile of the filtration area now proposed. Moreover, the center of the village, as indicated above, is only half a mile away and in the direction toward which the prevailing winds would tend to carry odors in the summer season.

The land at the location of the proposed disposal area is low and composed of peaty soil and other fine material, and if filters should be located at this place it would be necessary to haul the filtering material from some place where suitable material can be found.

It is impracticable, in the opinion of the Board, to purify the sewage and manufacturing wastes requiring purification by the plans presented, and if purification works should be located at the place proposed, objectionable odors from them would be likely to be noticeable at a large number of dwelling houses in the neighborhood.

WAREHAM (NEW BEDFORD AND AGAWAM FINISHING COMPANY).

SEPT. 13, 1911.

To MR. JOHN W. KNOWLES, *President, New Bedford & Agawam Finishing Company, Wareham, Mass.*

DEAR SIR: — The State Board of Health has considered your request for advice as to the disposal of wastes from your factory at Wareham and has caused the locality to be examined and samples of the wastes to be analyzed.

At the time this examination was made the quantity of wastes being discharged from the works amounted to about 75,000 gallons per day. These wastes, besides containing a considerable quantity of organic matter in solution, were very strongly alkaline on account of the use of much caustic soda in the processes carried on at the works. The wastes are pumped to a large open pool or settling basin on the westerly side of the river, whence they overflow to a secondary basin formed by dikes surrounding an area of ground approximately 200 feet long by 50 feet in width, and finally find their way through openings in the dike to the river.

It does not appear that the wastes at the present time are causing a serious nuisance in the Agawam River, but it is alleged that great injury has been done to the fish in the stream below the works, especially when large numbers of fish are present in the spring.

The most efficient plan of treating these wastes so as to prevent danger of injury to fish in the river will be to neutralize the wastes by the addition of acid. Judging from the samples taken from the works it will be necessary, in order to neutralize these wastes, to add sulphuric acid in amounts equal to about 10 pounds per thousand gallons or a total of 750 pounds per day when the quantity of wastes amounts to about 75,000 gallons per day, as was the case at the time of the examination. By the addition of this acid, moreover, a considerable coagulation of the organic matter present in the waste would be effected, and this matter, much of which would be deposited in the settling basin, could be kept out of the stream.

If it is decided to treat these wastes, tanks suitable for their treatment with acid should be constructed, and the wastes after treatment should be discharged into settling basins for the sedimentation and removal of the organic matter, and thence discharged into the river. It is possible that for the present at least, or until the quantity of wastes becomes greater than is indicated by the examinations that have thus far been made, they can at times be discharged directly into the river without causing serious injury to the fish, if outlets are placed at several points along the stream covering a distance of 400 or 500 feet. Small and constant streams of this waste discharging at these outlets might be diluted to such an extent by the river water as to be unobjectionable at all times of the year excepting when the alewives are running in the stream in the spring. During that period the wastes will have to be neutralized, if danger of injury to the fish is to be prevented.

WEYMOUTH (LAUNDRY IN SOUTH WEYMOUTH).

AUG. 3, 1911.

To Mr. H. W. DYER, *South Weymouth, Mass.*

DEAR SIR: — The State Board of Health received from you on July 1, 1911, an application requesting its advice as to a proposed plan of disposing of the wastes from your laundry at South Weymouth, accompanied by plans of the proposed works.

The plans provide for collecting the wastes in a settling tank from which they will overflow into a dosing tank and subsequently be discharged upon a filter bed in the rear of the laundry through pipes laid beneath the surface. According to the information furnished the Board, the total quantity of wastes to be disposed of amounts to about 13,500 gallons per day, the bulk of the wastes being discharged on Mondays to Thursdays, inclusive. The area of the proposed filter bed is about two-thirds of an acre, and it is proposed to discharge the sludge from the settling tank upon a sludge bed not far from the filter bed.

The Board has caused the locality to be examined by one of its engineers and has considered the plans presented, and is of the opinion that the plan of applying the wastes to the filter bed through pipes beneath the surface is a practicable method of disposing of these wastes unobjectionably under the existing circumstances. The character of the soil of the proposed filter bed appears to be coarse and porous, and if this is the case throughout the area it is probable that the size of the filter bed will be sufficient for the disposal of the wastes for some time in the future. The distributing pipes in such systems become clogged after a longer or shorter period of use and must be taken up and relaid from time to time in order to maintain the filter in satisfactory operation. A longer period of successful operation would probably be secured by laying the pipes with open joints surrounded and covered with stones from one to two inches in diameter, and filling the trench above them with graded gravel so as to allow the sewage to pass more freely into the ground. It is also advisable to lower the level of the ditch in the neighborhood of the filter bed, and thus make available a greater depth of filtering material.

The most serious danger of objectionable conditions in the operation of the proposed works is in the disposal of the sludge. If the sludge is discharged upon the proposed sludge bed and allowed to remain there to dry it is likely to create a very objectionable odor in the neighborhood. In order to avoid creating a nuisance it will be best to mix the sludge after it is discharged upon the bed with loam or ashes or other suitable material and cart it away to some place of disposal at a sufficient distance from dwelling houses.

With the modification suggested in the plans, the relaying of the distribution pipes when necessary and care in the disposal of the sludge, it is probable that the proposed works can be made to purify the wastes from the laundry so long as the quantity is no greater than it appears to be at the present time.

WOBURN (H. W. CLARK LEATHER COMPANY).

Nov. 2, 1911.

To the H. W. Clark Leather Company, Woburn, Mass.

GENTLEMEN: — The State Board of Health received from you on Sept. 26, 1911, an application for advice as to a proposed plan for the disposal of the drainage from your tannery in North Woburn, the details of which are described in your application as follows: —

> Drainage first passes into a pit, and from there follows the plank drain to a series of settling pits, 8x8x4. These are all on a level so that the water after filling the first pit, forces itself to the second and so on, until it reaches the coke filter.
>
> The first filter is covered with a spreader board, perforated. The water leaches down through the coke; the outlet being at the bottom, and then forces through to the next coke filter, and from there into a bin filled with small scrap iron, and then out into the ditch.
>
> The scrap iron is used for the purpose of taking out any sulphides in the water.

The ten settling pits are so arranged that the drainage may be turned into any one, leaving the others so that they may be cleaned out.

The Board has caused the locality to be examined by one of its engineers and has considered your application and the plan presented therewith. It appears that at the time of the examination the quantity of waste discharged from the tannery amounted to about 35,000 gallons per day. An analysis made to determine the general character of the waste at that time shows that it contains a large quantity of organic matter, the quantity of albuminoid ammonia being nearly twice as great as is ordinarily found in domestic sewage.

The plan submitted for the purification of this waste provides for a settling tank divided into ten compartments, so arranged that any one of them can be shut off for cleaning, but the method of removing the sludge from the tank or of its disposal is not presented. The waste contains a very large quantity of suspended matter, and in order to secure the best results from sedimentation, it will be necessary, in the opinion of the Board, to provide a larger tank capacity than proposed. It will also be of advantage to design the tanks in such a way that they can readily be cleaned, and suitable sludge beds should be provided on which the sludge from the tanks can be discharged for draining before it is removed to a place of disposal.

The filter beds shown upon the plan are wholly inadequate for the purification of these wastes to such an extent that it will be proper to discharge them into any of the tributaries of the Aberjona River. Experience in the treatment of wastes of similar character from other tanneries indicates that for the satisfactory purification of these wastes it will be necessary to provide suitable filter beds having an area of at least three-quarters of an acre. These filters can probably best be constructed of sand and gravel, of which there appears to be an abundance in the neighborhood of the tannery, and a suitable location can apparently be found without difficulty.

In view of the circumstances, the Board does not advise the adoption of the plan you have presented but recommends that a plan be prepared for the disposal of the waste from this tannery which will provide for larger settling tanks and for filter beds of a design which has been found suited to the purification of such wastes. The Board recommends that in the preparation of further plans you secure the assistance of an engineer of experience in the design and construction of works for the disposal of manufacturing wastes, and when you have prepared further plans the Board will give you further advice in this matter, if you so request.

MISCELLANEOUS.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to miscellaneous matters: —

BEVERLY (see SALEM).

BROCKTON (HIDE-ITE LEATHER COMPANY).

MAY 4, 1911.

To the Hide-ite Leather Company, Brockton, Mass., MR. F. V. CHANEY, *President.*

GENTLEMEN: — In response to your request for an examination of the waste from your mill, which is now being treated for the removal of organic matter, and advice as to the character of the waste after treatment, the Board has caused the works to be examined and samples of the waste before and after treatment to be analyzed.

It appears that at the present time the total quantity of waste from the mill is probably between 400,000 and 500,000 gallons per day when the plant is in full operation. The results of the analyses show that the waste contains a great quantity of finely ground matter in suspension, which is highly colored. This waste is discharged into two settling tanks each of 132,000 gallons capacity, from which, after sedimentation, the supernatant liquid is allowed to flow directly into the brook. The heavier liquid accumulating in the bottom of the tanks is returned for use in the mill, flowing by gravity through pipes leading from the bottom of the tanks. In time a heavy sludge, which does not flow out through these pipes, accumulates in the bottom of the tanks and this material is apparently flushed about once a month upon a sludge bed constructed of layers of gravel, clinker and crushed stone having an aggregate depth of about 15 inches. This bed is divided into two parts, a part of it being used for the filtration of water used for washing out the various machines and tanks in the mill. The effluent from this filter or strainer flows directly to the brook.

Analyses of samples of the waste liquid show that the raw waste contains a very large quantity of organic matter, the quantity of albuminoid ammonia amounting in the samples recently analyzed to 1.8 parts in 100,000. The supernatant liquid discharged into the stream contained at the time of the recent examination about 50 per cent. of the organic matter, as represented by the albuminoid ammonia, that was present in the original waste.

The effluent from the filter beds contained less organic matter than the supernatant liquor, the amount being about 30 per cent. smaller than was found in the analyses of the supernatant liquor.

The analyses of the water of Trout Brook above and below the works show that the quantity of organic matter, as shown by the albuminoid ammonia in the stream on April 17, at the time when the flow was quite large, was several times greater below the works than above it, indicating that the wastes still pollute the brook to a very serious extent. In order to prevent objectionable conditions in the stream below the point of discharge of this waste, it will be necessary, in the opinion of the Board, to purify the waste to a greater extent than is accomplished by the present works, and the Board recommends that the matter of providing further purification for these wastes be given immediate attention. The Board will, if you so request, advise you as to any plan that you may wish to present for the further purification of these wastes.

OCT. 5, 1911.

To the Hide-ite Leather Company, Brockton, Mass.

GENTLEMEN: — Recent examinations of the wastes discharged from your works into Trout Brook in Brockton show that they still contain an excessive amount of organic matter, which contributes seriously to the pollution of this stream and of the Matfield River below, causing complaint from residents in the neighborhood of these streams.

Unless more efficient means are provided without unnecessary delay to prevent pollution of the Matfield River and its tributaries by wastes from your works, it will become the duty of the Board to report the matter to the Attorney-General for such action as may be practicable under existing laws, in order to secure the abatement of this nuisance.

BROCKTON (BROCKTON GAS LIGHT COMPANY).

OCT. 5, 1911.

To the Brockton Gas Light Company, Brockton, Mass.

GENTLEMEN: — Recent examinations of the wastes discharged from your works into the Vinegar Swamp Drain, so called, which has an outlet into the Salisbury Plain River in Brockton, show that they still contain an excessive amount of organic matter, which contributes seriously to the pollution of this stream and of the Matfield River below, causing complaint from residents in the neighborhood of these streams.

Unless more efficient means are provided without unnecessary delay to prevent pollution of the Matfield River and its tributaries by wastes from your works, it will become the duty of the Board to report the matter to the Attorney-General for such action as may be practicable under existing laws, in order to secure the abatement of this nuisance.

BROCKTON (EMPIRE LAUNDRY COMPANY).

To the Empire Laundry Company, Brockton, Mass. OCT. 5, 1911.

GENTLEMEN: — Recent examinations of the wastes discharged from your works into Salisbury Brook in Brockton show that they still contain an excessive amount of organic matter, which contributes seriously to the pollution of this stream and of the Matfield River below, causing complaint from residents in the neighborhood of these streams.

Unless more efficient means are provided without unnecessary delay to prevent pollution of the Matfield River and its tributaries by wastes from your works, it will become the duty of the Board to report the matter to the Attorney-General for such action as may be practicable under existing laws, in order to secure the abatement of this nuisance.

CANTON (SPRINGDALE FINISHING COMPANY).

To the Springdale Finishing Company, Canton, Mass. JAN. 5, 1911.

GENTLEMEN: — The State Board of Health has received from you through your engineer, Mr. William S. Johnson of Boston, the following communication requesting its advice as to what portions of the wastes discharged from the operations carried on in your factory require purification and as to those which may reasonably be permitted to flow into the stream untreated: —

> At the request of the Springdale Finishing Company I am sending herewith plans of works for the purification of the objectionable wastes from the factory for your advice.
>
> When these plans were prepared, it was proposed to pump the wastes from the lower mill to the settling tanks and to collect the wastes from the other mills by gravity. It is probable that we shall change the plans, lowering the settling tanks sufficiently to permit the discharge of wastes from the lower mill, as well as the wastes from the upper mills, into the tanks by gravity. This will make the settling tanks somewhat shallower, and may require the lowering of the grade of the filter beds somewhat.
>
> We do not wish to collect any wastes for treatment which do not require purification. You have had many samples of wastes collected from the different processes, and are familiar with their character. We should like, therefore, before doing any work in the buildings to obtain your advice as to what wastes must be purified and what may reasonably be permitted to go into the stream untreated.

The Board has considered your application and the plans submitted therewith and has caused further samples of the wastes from the works of the Springdale Finishing Company to be analyzed. The results of these and previous examinations show that there has been considerable change from time to time in the character of the wastes discharged from the various processes carried on in this factory, and at the present time it appears that experiments are being made with various materials with a view to their use in these processes, which may result in further changes in the amount and character of the wastes. At the time the recent examination was made 14 samples of waste water were collected from the different processes or from different stages in these processes, and from the results of the analyses of these samples it appears that it will probably be practicable, if the wastes contain no greater quantities of organic matter than were indicated at the time of the recent examination, and if their quantities remain approximately the same, to discharge into the stream the waste wash water after soaping, amounting to about 1,000 gallons per day, the waste wash water discharged from the silicate machine, amounting to about 5,000 gallons per day and the scouring machine waste after acid treatment, amounting to about 31,000 gallons per day. It is probable that most of the waste wash water after dyeing can also be allowed to flow into the stream without treatment, but it will be essential that the highly colored portions of this waste dye wash, which probably contains a large quantity of organic matter, be included with the waste to be purified.

The Board during the year 1909 made experiments upon the purification of the various wastes discharged from this mill at that time, the results of which indicated that when the wastes, after thorough sedimentation, were applied to a sand filter at a rate of 50,000 gallons per acre daily, the effluent was satisfactorily purified. There have been changes in the processes carried on in the works since that time, and it is understood that further changes are in contemplation, and you also propose changes in the plans as presented. Under the circumstances the Board cannot advise you definitely at the present time as to the plans presented for the purification of this waste.

Judging from the results of the experiments, as stated above, it is probable that, making due allowance for the quantity of waste waters which may reasonably be discharged into the stream without treatment, it will still be necessary, in order to purify the wastes at present discharged from the factory, if they remain about the same in quantity and character as at present, to provide a larger area of filter beds than is shown on the plan; and the Board recommends that at least two acres of filter beds be constructed in the beginning, and that the plans be so designed that the area can be increased if necessary without material changes.

It is also important that a settling tank of large capacity be provided, as proposed in the plan presented for the treatment of the wastes before filtration, since the experiments have shown that a considerable quantity of organic matter can be removed by sedimentation, thus probably increasing the amount that can be treated upon the filters. Sludge beds should also be provided to receive the sediment discharged from the settling tank.

COHASSET AND HULL.

OCT. 5, 1911.

To Messrs. IRVING F. SYLVESTER, *Secretary, Board of Health of the Town of Cohasset*, and FRANCIS H. CLEVERLY, *Secretary, Board of Health of the Town of Hull.*

GENTLEMEN: — The State Board of Health has considered your communication relative to the condition of Straits Pond in the towns of Cohasset and Hull, and has again caused an examination of the pond to be made, to determine what changes, if any, have taken place in its condition since the previous investigations by this department.

The results of the recent examination do not show that any very material change has taken place in the condition of this pond, as compared with its condition in 1905 or in 1900, when a very thorough investigation was made relative to a proposed plan of improving the condition of the pond.

Straits Pond has been a source of complaint for more than thirty years. The pond is shallow, with a muddy bottom, from which weeds and water plants grow nearly or quite to the surface of the water, in the summer season, over much of the area of the pond, and these organisms enmesh considerable floating matter, which inevitably finds its way into the pond in the midst of a large population. The decay of the plants and organic matters causes objectionable odors, especially in the latter part of the summer, which are apparently more serious in some years than in others.

There does not appear to be any practicable plan, in the opinion of the Board, of treating this pond or its waters in such a way as to prevent the objectionable conditions complained of unless at large expense. The most effective plan of treating the waters of this pond, and the only one by which it appears probable that a satisfactory improvement in the condition of the pond can be effected, is the plan suggested in the reply of the Board to certain citizens of Hull and Cohasset, dated Nov. 1, 1900, as follows: —

> To effect a further improvement in the character of this pond will require the removal from its entire bottom of the mud and organic matter which now give rise to the growth of water plants and organisms. It

may be practicable in the deeper parts of the pond where the removal of the mud would be more expensive, to prevent its causing trouble by covering it with a layer of sand or gravel. If clean salt water were then introduced as proposed a satisfactory improvement in the condition of the pond would be effected. On account of the large area of the bottom of the pond requiring treatment, the cost of suitable improvement will be large.

A full copy of that reply is appended hereto.

It is desirable that the depth of the pond be increased as much as practicable, and the mud and organic matter removed from the bottom can be deposited in the shallow places about the shores of the pond where, if covered with gravel and faced if necessary where exposed to the waves with larger stones, it will be unobjectionable; but before deciding upon a plan for improving the condition of this pond it is important that surveys be made and plans prepared to serve as a basis for estimating the probable cost of the work.

EAST BRIDGEWATER.

OCT. 5, 1911.

To the Board of Health, East Bridgewater, Mass.

GENTLEMEN: — The State Board of Health has considered your further complaint regarding the nuisance in the Matfield River in East Bridgewater and has made a further examination of this stream and its tributaries, including the sources of pollution found to exist thereon.

One of the chief pollutions of the stream, caused by the overflow of considerable quantities of sewage from the reservoirs of the Brockton sewerage system, was discontinued at the end of July. Pollution is still caused by the discharge of foul wastes into the stream from certain establishments on its banks or near its tributaries, and these establishments have been notified to discontinue the further discharge of polluting matters into the stream.

While a large reduction in the quantity of foul matter discharged into the river has already been effected, it will probably be some time before a material improvement will be noted in the condition of the river. If, after a reasonable time, the river continues to be objectionable, the Board will upon application take such further action as appears to be in its power.

In the course of these investigations it has been found that the sewage of the Carver Cotton Gin Company is discharged directly into a tributary of the Matfield River within the limits of East Bridgewater and not far from the main stream. This pollution undoubtedly contributes to the objectionable condition of the Matfield River.

The pollution of the Matfield River or its tributaries within the limits of East Bridgewater, tending to increase the nuisance therein, can probably be prevented by action by your department.

EAST BRIDGEWATER (CARVER COTTON GIN COMPANY).

OCT. 5, 1911.

To the Carver Cotton Gin Company, East Bridgewater, Mass.

GENTLEMEN: — Complaint has been made of the condition of the Matfield River and its tributaries, and an investigation by this Board shows that the stream is badly polluted and in an objectionable condition throughout much of its course in East Bridgewater. In the course of this examination it has been found that the sewage from your works is discharged directly into a tributary of the Matfield River, not far from the main stream, and contributes to the objectionable condition of this river.

The Board recommends that the discharge of sewage from your works into the neighboring stream be discontinued and provision made for its proper disposal elsewhere.

FITCHBURG (STAR WORSTED COMPANY).

AUG. 3, 1911.

To the Star Worsted Company, Fitchburg, Mass., Mr. C. B. SMITH, *Treasurer.*

GENTLEMEN: — In reply to your communication received July 15, 1911, requesting advice as to the disposal of the manufacturing waste from your works, now discharged into the north branch of the Nashua River, the Board has caused the locality to be examined and samples of the wastes discharged into the river at the present time to be analyzed.

The results of the examination show that the chief waste from your works which now pollutes the north branch of the Nashua River is the effluent from the process of scouring yearly about 2,500,000 pounds of wool in the grease. The quantity of wool-scouring effluent is apparently from 4,000 to 8,000 gallons per day, but the quantity of organic matter contained in this waste is more than twenty-five times as great as that found in ordinary sewage. There is no question that this waste forms a very serious pollution of the river at the present time and should be removed from the river as soon as practicable.

The best plan of disposing of this waste will probably be to discharge it into the city sewers, but the authorities in charge of the sewers will no doubt in future limit the admission of manufacturing wastes to the sewers to the extent at least of requiring that when necessary such wastes shall first be treated for the removal of matters which may have a tendency to interfere with the operation of the sewers or of the sewage-disposal works, and it is unlikely that the wool-scouring wastes from your mill would be admitted to the sewers unless they should first be passed through suitable settling tanks for the removal of sand and heavy matters which might interfere with the flow in the sewers, and subsequently be treated for the removal of fats which would interfere with the operation of the filter beds.

The quantity of the wool-scouring waste discharged at this mill is much smaller than at other mills in the State where such wastes are treated for the removal of fats and other matters, and it is probable that a process could be installed at your factory for treating these wastes to such an extent that they will be admissible to the sewers at a reasonable cost. The extent of the works necessary for this treatment and their probable cost can be ascertained very closely beforehand by an engineer familiar with the construction and operation of such works.

It is of course possible to purify the wastes, if you prefer, to such an extent that they can be allowed to discharge directly into the river. Considering the circumstances, the Board recommends that you secure the advice of an engineer of experience in the treatment of such wastes, to prepare a plan for treating these wastes to such an extent that they will be admissible to the sewers or to the further degree that may be necessary for their admission to the river. When you have prepared a plan for the further treatment of the wastes, the Board will, if you so request, give you further advice in this matter.

HULL (see COHASSET).

LEICESTER.

SEPT. 7, 1911.

To the Board of Health, Leicester, Mass.

GENTLEMEN: — Complaint having been made to this Board of a nuisance in the stream known as Kettle Brook in Worcester, believed to be due to the pollution of the stream by woolen mills in Worcester and Leicester, the Board has caused the locality to be examined and finds that the chief cause of the objectionable conditions complained of is the discharge of sewage and manufacturing wastes into the stream from certain mills in the town of Leicester and the city of Worcester. The Board has recommended to these mills that provision be made for purifying these wastes in order to prevent the continued objectionable pollution of this stream. Copies of the recommendations of the Board to the various mills are enclosed herewith for your information.

LEICESTER (VALLEY WOOLEN MILL).

SEPT. 7, 1911.

To the Valley Woolen Mill, MR. CHANNING SMITH, *Proprietor, Leicester, Mass.*

GENTLEMEN: — Complaint has been made to this Board of a nuisance in Kettle Brook, also known as the Cherry Valley River, at points in the town of Leicester and city of Worcester, and careful examinations made by the Board, recently, show that the stream is very badly polluted from the Bottomly Mill throughout the remainder of the course of the brook in Leicester and for a long distance within the territory of the city of Worcester.

One of the causes of the offensive condition of the brook within the limits indicated is the waste discharged from the manufacturing processes carried on in the Valley Woolen Mill and the sewage of the operatives, all of which is discharged untreated into the stream. It is essential for the prevention of further nuisance in the valley of Kettle Brook below this mill and the protection of the public health that the pollution of the stream by sewage and manufacturing wastes from your mill shall be discontinued. The Board recommends that you provide without delay the necessary works for removing from the stream the sewage and manufacturing waste from your factory and for their treatment or purification in such a way that they will not cause further objectionable pollution of the river. It is possible that a portion of the water used in rinsing the cloth can continue to be discharged into the stream, for a time at least, without objection.

It is important in planning for the treatment of these wastes to secure the assistance of an engineer of experience in such matters, and the engineer of the Board will supply your expert with such information as has been collected by the Board relative to the quantity and character of the manufacturing wastes from your mill and such information as is available relative to the methods by which they can be purified. When you have prepared a plan for the disposal of the sewage and the treatment of the wastes from your mill, the Board will advise you concerning it, if you so request.

Similar communications were sent, under same date, to the George W. Olney Woolen Company and the Chapel Mills Manufacturing Company.

LYNN.

To the Board of Health of the City of Lynn. SEPT. 7, 1911.

GENTLEMEN: — The State Board of Health received from you on July 26, 1911, a communication requesting its advice as to improving the condition of Flax Pond, accompanied by a petition from numerous residents about the pond, alleging the existence of very objectionable conditions in its neighborhood, and in response to this petition the Board has caused the locality to be examined and samples of the water of the pond and of the stream which feeds it, including also Wyoma Lake its principal affluent, to be analyzed.

The results of the examination show that Flax Pond probably receives but little pollution from the dwelling houses and other buildings immediately about its shores and, so far as can be determined at the present time, there are no sewers or drains discharging polluting matter directly into the pond; but Halls Brook, the stream which enters the pond from Wyoma Lake, is being very badly polluted, evidently by wastes discharged from the Illinois Leather Company which is situated near the brook above the pond and disposes of a large quantity of waste matter in the immediate neighborhood of the stream. The quantity of organic matter in the water of Sluice Pond is about the same as is ordinarily found in ponds in this region at this season of the year, but the quantity of organic matter found in the water entering Halls Brook below the works of the Illinois Leather Company is greater, as indicated by the albuminoid ammonia, than is ordinarily found in sewage. This organic matter is evidently derived from the refuse from this factory which is deposited not far from the stream.

The work carried on at the Illinois Leather Company is the washing of hair received from tanneries in the neighborhood and its preparation for use in mortar and for other purposes. The liquid wastes from this process amount apparently to as much as 350,000 gallons per day and contain a large quantity of lime in suspension mingled with dirt and organic matter, including a small quantity of sewage from the factory. These wastes at the present time pass through settling tanks and the supernatant liquor is discharged into the city sewer. The solid matter, or sludge, which collects in the tanks is discharged from time to time upon a sludge bed and subsequently removed and deposited in the valley of Halls Brook below the factory. No provision appears to have been made for draining the sludge beds to the sewer, and whatever water drains out of the final deposits below the factory finds its way into Halls Brook. The sludge deposits are unsightly in appearance and at times an objectionable odor is noticeable in their neighborhood.

Flax Pond at the present time contains a very large quantity of organic matter, largely in the form of organic growths which consist for the most part of blue-green *Algæ.* These organisms, which are present in this case in such numbers as to impart a disagreeable odor to the water, are found quite commonly in the waters of ponds and reservoirs at this season of the year, and experience has shown that they grow much more abundantly in polluted than in unpolluted waters.

In order to prevent the pollution of Flax Pond by wastes from the Illinois Leather Company it will be necessary either that the wet sludge from the settling tanks be removed wholly from this locality to some suitable place of disposal, or that it be thoroughly dried upon properly prepared sludge beds drained to the sewer, and if subsequently deposited in the neighborhood of the brook or Flax Pond that it be thoroughly covered with earth or ashes so that no portion of it can be washed into the brook or the pond. It is also important that the existing deposits be thoroughly covered so that no further portion of them can be washed into the pond. All sewage should be wholly separated from the wastes of this factory and discharged into the sewers through a separate pipe.

Examinations of the region about Flax Pond do not show any other serious sources of pollution with the exception of the waste discharged from the Illinois Leather Company.

An examination of a sample of ice found in one of the ice-houses on the shore of the pond shows that while it contained a slightly greater quantity of organic matter than is found in good ice this sample was nearly free from bacteria and was probably safe for domestic use. Considering the character of the pond, however, and its exposure to pollution, the only way in which ice of good quality which may safely be used for domestic purposes can with certainty be obtained from this source in future will be by removing from the ice, before using, all snow ice including the first inch of clear ice that forms upon the pond, and rejecting all ice containing particles of foreign matter.

The Board recommends that the Illinois Leather Company be required to provide for the proper disposal of the sewage and all other wastes from its factory in such manner that they will not hereafter pollute Flax Pond or any of its tributaries. The Board further recommends that the deposit of sludge and other foul matters in the neighborhood of Halls Brook be covered with earth or clean ashes so as to prevent odors therefrom and the danger of the further washing of any of this material into the pond or any of its tributaries, and that all sewage from the factory be kept separate from the other wastes and discharged into the sewers. If the present objectionable deposits of sludge about the factory are thoroughly covered to prevent further pollution of the brook therefrom, suitable sludge beds provided and the disposal of the sludge properly carried out as herein suggested, it is probable that the further pollution of the brook from this factory can be prevented.

MANSFIELD.

Oct. 5, 1911.

To the Board of Health of the Town of Mansfield, Mr. E. G. SHERMAN, *Clerk.*

GENTLEMEN: — The State Board of Health received from you on Aug. 19, 1911, a communication enclosing letters of complaint regarding the pollution of a canal or mill-race in the town of Mansfield by wastes from a wet-wash laundry, and you request the Board either to take action to prevent further trouble, or to advise you as to a method by which the objectionable conditions can be removed.

The Board has caused the locality to be examined by one of its engineers and finds that the nuisance complained of is caused by the discharge on two days of the week of a total of about 50,000 gallons of wash water from a laundry into a raceway leading from the laundry to the stream which flows from Fulton's Pond and passes under West Street to the pond of Kingman & Hodges. It appears that the wastes from the laundry are discharged chiefly on only two days of the week, but that very little other water is discharged into this raceway. There is a low dam across the raceway, which forms a pool in the rear of the house of the chief complainant, and organic matter from the waste, collecting on the bottom and sides of the stream, especially in the pool, and putrefying, creates a very objectionable nuisance in hot weather. If the dam should be removed from the raceway and its bottom made smooth down to the junction with the main stream near West Street, or if the wastes should be conveyed to the main stream above Kingman & Hodges pond in a separate pipe, the nuisance in the immediate neighborhood of the laundry and the house of O. P. Cook could doubtless be prevented, but objectionable conditions would probably be created in the Kingman & Hodges pond.

Considering the circumstances, the best practicable plan of preventing danger of serious nuisance from these wastes will be to purify them as well as practicable on land in the neighborhood of the laundry until a sewer has been provided, into which they can be discharged and removed from the district. The land lying between Fulton's Pond and the raceway west of the factory appears to contain soil suitable for the purification of these wastes by intermittent filtration, and by the construction of suitable filters in this locality the wastes can be purified sufficiently so that the effluent can be discharged into the stream leading from Fulton's Pond without causing objectionable conditions below.

A filter bed having an area of one-third of an acre and a depth of filtering material of about 4 feet will probably be sufficient to provide adequately for the purification of these wastes while the quantity is no greater than at present. A filter bed in this locality, if kept in good order, is not likely to be seriously objectionable, but it will be best to remove the wastes wholly from the district as soon as the construction of sewers makes removal practicable.

Your board possesses full power under existing laws to abate this nuisance.

NORTON (TALBOT WOOL SCOURING COMPANY).

DEC. 7, 1911.

To the Talbot Wool Scouring Company, Norton, Mass.

GENTLEMEN: — A petition having been presented to this Board, alleging the serious pollution of the Three Mile River, — a stream running from the town of Norton through territory of the city of Taunton to the Taunton River, — the Board has caused the stream and its tributaries to be examined and finds that the waters of the Three Mile River and especially one of its main tributaries, known as the Rumford River, in portions of the town of Norton are very badly polluted and have been the source of a serious nuisance during much of the past year.

The chief cause of the objectionable conditions of which complaint is made is the discharge into the Rumford River in the town of Norton of wastes from the process of scouring and treating wool at your factory. These wastes have been found upon examination to contain an excessive quantity of fats and other organic matters, and their effect upon the stream has been such as to make it offensive in appearance and odor for a distance of many miles below your factory.

The Board recommends that you take such measures as will prevent the further objectionable pollution of the Three Mile River or its tributary, the Rumford River, or any of their tributaries, by sewage waste or refuse from your mill.

PITTSFIELD.

JULY 6, 1911.

To the Love of Peace Society, Inc., Pittsfield, Mass., MR. ALEXANDER COOPER, *President.*

GENTLEMEN: — The State Board of Health received from you on June 1, 1911, an application for the approval of this Board, under the provisions of chapter 379 of the Acts of the year 1908, of the use of a certain area of land for cemetery purposes situated on Elm Street in Pittsfield, opposite the Dalton road. The application, which is accompanied by a plan of the proposed area, is as follows: —

The undersigned, in behalf of the Love of Peace Society, Incorporated, respectfully represents that said society have secured an option upon certain lands located on the easterly side of Pittsfield, consisting of four acres of land, which it intends to use for a burial ground, with your approval. The undersigned further represents that no surface water or ground drainage from said lands, can enter any stream, pond, reservoir, well, filter gallery or other water used by any city or town or water company as a source of public water supply, or any tributary of a source so used, or any aqueduct or other works used in connection therewith, and request your approval to use the said lands for a burial ground. A plan of said lands is herewith submitted for your information.

The Board has caused the locality to be examined and finds that a portion of this area is within the watershed of Sacket Brook and the remainder within that of Goodrich Pond. Sacket Brook below this point is one of the sources of water supply of the city of Pittsfield and the city desires to retain control of this source of supply for future use in case of need. About half of the area of the proposed cemetery is within the Sacket Brook watershed, and under the circumstances the Board does not believe it advisable that this portion of the area should be used for cemetery purposes. The Board recommends that you consider the practicability of securing a suitable area for a cemetery that will be outside of the watershed of any of the sources of water supply of the city.

SALEM AND BEVERLY.

SEPT. 7, 1911.

To the Joint Board on the Investigation of the Reconstruction of the Essex Bridge.

GENTLEMEN: — The State Board of Health has considered your communication of Aug. 16, 1911, relative to your proposed investigation as to the construction of a dam or bridge between the cities of Salem and Beverly, under the provisions of chapter 100 of the Resolves of 1911, requesting the opinion of the Board relative to the probable effect of the proposed dam.

The Board, as you state, has made many investigations as to the conditions of North River, especially in connection with the sewerage of Salem and Beverly and the prevention of the pollution of that estuary; but the Board has not investigated the question of the probable effect of the dam at Essex Bridge and is not able without an investigation to give an opinion whether it would be safe and sanitary under existing conditions to construct a dam at that point at the present time, or whether it would be wise to change the existing conditions so as to render it safe and sanitary to build a dam, in order still further to improve the conditions.

The Board will be pleased to furnish your joint board with any information that it may have that will aid you in the investigation. It may be the part of sincerity to add, however, that the Board has all the work on its hands that the appropriations made for its use will warrant its undertaking this year.

STOUGHTON.

JULY 6, 1911.

To the Board of Selectmen of the Town of Stoughton, Mr. CORNELIUS HEALY, Jr., *Chairman.*

GENTLEMEN: — Enclosed herewith is an order of the State Board of Health adopted July 5, 1906, under the provisions of chapter 541 of the Acts of the year 1902, as amended by chapter 360 of the Acts of the year 1906, prohibiting the entrance or discharge of sewage into any part of the Neponset River or its tributaries, and the entrance or discharge therein of every other substance which may be injurious to public health or may tend to create a public nuisance.

It appears that the town of Stoughton is discharging sewage into the Neponset River or its tributaries in disregard of the said order.

The town of Stoughton is hereby notified that the discharge of sewage by it into the Neponset River or its tributaries is prohibited and must be discontinued forthwith.

STOUGHTON (FRENCH & WARD).

NOV. 13, 1911.

To Messrs. FRENCH & WARD, *West Stoughton, Mass.*

GENTLEMEN: — In response to your request for an examination of the operation of the filter beds at your works and advice as to the disposal of the waste, the State Board of Health has caused further examinations to be made of the quantity and character of the wastes discharged from your mill and of the results of the operation of the filter beds now in use for the treatment of these wastes.

At present the filter beds have an area of about one-half an acre. They were designed for the treatment of the waste from the mill at a time when the total quantity amounted to about 60,000 gallons per day, of which 30,000 to 40,000 gallons were seriously polluted. The recent measurements show that the total quantity of the waste discharged from the mill amounts to about 80,000 gallons per day, of which nearly 50,000 gallons are evidently very seriously polluted.

An examination of your filter beds shows that they have become badly clogged, a condition which is due evidently to the fact that the quantity of waste applied to them is much greater than filter beds of this area are capable of purifying efficiently, and the Board recommends that the area of filter beds be enlarged as soon as practicable. If the increase in the area of the filter beds should be made proportionate to the increase in the quantity of wastes discharged from your mill, it would require an enlargement of the filtration area of about 50 per cent. or about one-quarter of an acre; but there will be much advantage in operating the filters if a larger increase should be provided, and provision would also be made for any further increase that may occur in the quantity of foul waste discharged from the mill.

The Board further recommends that as soon as the additional area has been provided the present filter beds be cleaned and put in a condition for satisfactory operation, and that all of the foul wastes from the mill be applied to them at all times.

It is probable that about one-third, or possibly somewhat more, of the water now used in rinsing cloth could be discharged into the river without treatment, but the works must be so arranged that none of the waste containing a considerable quantity of polluting matter shall be allowed to escape into the stream.

TAUNTON.

DEC. 7, 1911.

To Mr. ALBERT C. CRANE, *Taunton, Mass.*

DEAR SIR: — In response to your petition, dated Aug. 26, 1911, alleging pollution of the Three Mile River, so called, running from the town of Norton through certain districts in the city of Taunton to the Taunton River, by reason of sewage and mill waste being emptied into said stream, the Board has caused the river and its tributaries and the sources of pollution thereon to be examined and samples of the waters of the stream, collected at various points, to be analyzed.

The results show that the Three Mile River and its tributaries are badly polluted by the discharge of wool-scouring wastes from a mill in Norton and to a less extent by polluting matters discharged into the river and its tributaries at several other points within its watershed.

The Board, acting under the provisions of chapter 75 of the Revised Laws, has called attention to the pollution of the river, and recommended to the persons responsible for this pollution that they desist therefrom and purify their objectionable wastes before discharging them into the stream.

WAREHAM (ONSET).

JUNE 1, 1911.

To the Board of Health of the Town of Wareham.

GENTLEMEN: — Complaint has been made to this Board that sewage from certain cottages in the neighborhood of Glen Cove in the Onset district of the town of Wareham is discharged upon flats and into waters from which shellfish are taken for food, and the Board has caused the locality to be examined by one of its engineers and by the state inspector of health of the district.

From these examinations it appears that cottages supported largely on piles have been constructed at the edge of East River, extending over the beach, and that sewage from these buildings is discharged into boxes on the beach which are covered with the water of the cove at high tide. These boxes are loosely constructed and the sewage evidently finds its way into the water in the immediate neighborhood of places from which shellfish are taken for food. In the case of a few of these houses masonry cesspools have been constructed, from which the sewage can be removed to some suitable place of disposal. The further occupation of these cottages or any of them should be prevented unless adequate means is provided for properly disposing of the sewage, sink drainage and all other foul wastes in such a manner that there will be no further danger of nuisance or the pollution of adjacent waters or flats.

Your board apparently has authority to prevent these objectionable conditions by action under the provisions of chapter 75 of the Revised Laws (see especially sections 65 and 67), and the Board recommends that the necessary action be taken with as little delay as practicable.

WATERTOWN.

MAY 4, 1911.

To the Proprietors of the Cemetery of Mount Auburn, Mr. PRENTISS CUMMINGS, *President.*

GENTLEMEN: — The State Board of Health received from you on March 31, 1911, the following petition requesting the consent of the Board, under the provisions of chapter 139 of the Acts of the year 1911, to the inclusion within the Cemetery of Mount Auburn of certain lands now owned by the proprietors of said cemetery and described in the petition: —

The undersigned respectfully petitions for the consent of said board to include within the Cemetery of Mount Auburn land now owned by your petitioner lying between Mount Auburn Street, the Watertown Branch of the Fitchburg Railroad, Cottage Street, Sawin Street, land now or late of Patrick Doody, and by other land of your petitioner included within the present cemetery; the land thus added being a little more than one acre commonly called the Railroad Lot and the Bird Lot, said Railroad Lot being land by mistake of measurement not included within the cemetery originally. Said lots are shown and are tinted purple on plan annexed hereto as part of this petition.

The Board has also received a copy of the vote of the board of health of the town of Watertown, assenting to the inclusion of the lands in question within the Cemetery of Mount Auburn under the provisions of said chapter 139.

The Board has caused the locality to be examined by one of its engineers and has considered the petition and plan presented, and hereby consents to the inclusion within the Cemetery of Mount Auburn of certain lands, having an area of a little over one acre, commonly called the Railroad Lot and the Bird Lot, and lying between Mount Auburn Street, the Watertown Branch of the Fitchburg Railroad, Cottage Street, Sawin Street, land now or formerly of Patrick Doody and land of Cemetery of Mount Auburn, as shown upon the plan annexed to your petition.

WOBURN.

Nov. 2, 1911.

To Messrs. ALVAH S. WOOD and Others, *Woburn, Mass.*

GENTLEMEN: — The State Board of Health has considered your petition received Oct. 3, 1911, alleging an unhealthy condition amounting to a public nuisance near Monroe Street in Woburn, and has caused the locality to be examined by its engineer.

The results of the examination indicate that the chief cause of complaint is an offensive odor arising from a deposit of sludge which had recently been discharged from settling tanks connected with the factory of the Champion Tanning Company. It appears that the manufacturing wastes from this tannery, amounting at the time of the recent examination to about 16,000 gallons per day, are passed through settling tanks for the purpose of removing suspended matters before being discharged into the sewers, and that the contents of these tanks are from time to time discharged upon crude sludge beds near the tanks, where they are allowed to remain until sufficiently dried and are then removed to a neighboring dump. These sludge beds are objectionable both on account of the odors which arise from the sludge deposits and on account of the danger of pollution of adjacent waters by sludge or by liquid draining therefrom.

The authority to deal with the question of any nuisance that may be caused by these deposits rests with the local board of health. The duties of the State Board of Health in the matter relate to the prevention of the pollution of the Aberjona River and its tributaries, and the Board has notified the owners of the tannery of the danger of the pollution of those waters by sludge or by drainage from the sludge beds, under existing conditions.

It is very doubtful, in the opinion of the Board, whether deposits from the settling tanks can be drained upon sludge beds in the neighborhood of the tanks without creating objectionable conditions at times, but it is probable that, if properly designed sludge beds draining to a sewer should be constructed as far as practicable from dwelling houses in this neighborhood, and the sludge after draining should be covered and composted with loam or other material and removed promptly to some suitable place of final disposal, objectionable odors would not be noticeable at dwelling houses in the neighborhood, unless in warm weather, when if necessary the contents of the tanks could be removed in suitable receptacles to some unobjectionable place of disposal.

WOBURN (CHAMPION TANNING COMPANY).

Nov. 2, 1911.

To the Champion Tanning Company, Woburn, Mass.

GENTLEMEN: — Complaint having been made to this Board of an alleged nuisance in the neighborhood of your tannery on Monroe Street, the State Board of Health has caused the locality to be examined by its engineer and finds that the probable chief cause of the objectionable conditions complained of recently is the method of disposal of the sludge from the settling tanks through which the drainage from your works is passed before being discharged into the sewer.

From examinations of the locality it appears that the contents of the settling tanks, which are cleaned out apparently about once a month at the present time but more frequently when the tannery is in full operation, are pumped to two sludge beds, one of which is located north of the tank and close to North Warren Street on ground which has apparently been filled somewhat with municipal refuse, while the other is located east of the tank in low ground where the soil is apparently fine and nearly impervious. Under existing conditions the liquid contained in the sludge does not drain away readily and a considerable time elapses, — sometimes several weeks, — before the solid matter is dried to such a degree that it can be easily removed to a place of final disposal.

It is evident, in the opinion of the Board, that these sludge beds are not well adapted to the purpose for which they are used, and the disposal of sludge on these beds is objectionable both on account of the offensive odors which arise from them and on account of the danger of pollution of adjacent waters by the sludge or liquid draining therefrom. In order to prevent further danger of the pollution of tributaries of the Aberjona River and violation of the provisions of chapter 291 of the Acts of the year 1911, it is important that suitable sludge beds should be constructed which will prevent the danger of pollution of local waters either by the escape of sludge or by foul drainage therefrom.

It is doubtful, in the opinion of the Board, whether the deposits from the settling tanks can be treated upon sludge beds in the neighborhood of the tanks without creating objectionable conditions, but if properly designed sludge beds should be constructed, as far as practicable from dwelling houses, and the sludge after draining should be covered and composted with loam or other suitable material and removed promptly to some suitable place of final disposal, very little serious objection might result from the treatment of the sludge in this locality. The sludge beds should be constructed of porous material suitably underdrained, and the underdrains should discharge into the sewer, so that the liquid contained in the sludge will readily drain away without polluting local waters. If in warm weather the use of sludge beds in this locality should become objectionable, it will be necessary to remove the liquid sludge in suitable receptacles to some proper place of disposal.

It is probable that covering the settling tanks would have a further tendency to prevent objectionable odors in this locality, and by surrounding the sludge beds with a growth of shrubs and trees the danger of objectionable odors therefrom being carried about the neighborhood will be diminished.

WORCESTER.

SEPT. 7, 1911.

To MR. JAMES C. COFFEY, *Executive Officer of the Board of Health, Worcester, Mass.*

DEAR SIR: — In response to your communication of Aug. 10, 1911, relative to complaints of the condition of Kettle Brook in the vicinity of Ludlow and Main streets, requesting the assistance of this Board in abating the nuisance there, the Board has examined the locality and finds that the cause of the pollution of the stream is chiefly the discharge of sewage and manufacturing wastes from certain woolen mills in Leicester and Worcester, and has notified the various mills from which foul manufacturing waste or sewage was found to be flowing into the stream of the results of its investigation, and made recommendations as to the prevention of future nuisance. Copies of these communications are enclosed herewith for your information.

WORCESTER (G. E. DUFFY MANUFACTURING COMPANY).

SEPT. 7, 1911.

To the G. E. Duffy Manufacturing Company, Mr. G. E. DUFFY, *President, Worcester, Mass.*

GENTLEMEN: — Complaint has been made to this Board of a nuisance in Kettle Brook, also known as the Cherry Valley River, at points in the town of Leicester and the city of Worcester, and careful examinations made by the Board, recently, show that the stream is very badly polluted from the Bottomly Mill throughout the remainder of the course of the brook in Leicester and for a long distance within the territory of the city of Worcester.

One of the causes of the offensive condition of the brook within the limits indicated is the waste discharged from the manufacturing processes carried on in your mill and the sewage of the operatives, a portion of which is discharged untreated into the stream. It is essential for the prevention of further nuisance in the valley of Kettle Brook below this mill and the protection of the public health that the pollution of the stream by sewage and manufacturing wastes from your mill shall be discontinued. The Board recommends that you provide without delay the necessary works for removing from the stream the sewage and manufacturing waste from your factory and for their treatment or purification in such a way that they will not cause further objectionable pollution of the river. It is possible that a portion of the water used in rinsing the cloth can continue to be discharged into the stream, for a time at least, without objection.

It is important in planning for the treatment of these wastes to secure the assistance of an engineer of experience in such matters, and the engineer of the Board will supply your expert with such information as has been collected by the Board relative to the quantity and character of the manufacturing wastes from your mill and such information as is available relative to the methods by which they can be purified. When you have prepared a plan for the disposal of the sewage and the treatment of the wastes from your mill, the Board will advise you concerning it, if you so request.

Similar communications were sent under same date to the Darling Woolen Mills Company and Mr. P. F. Pfaffman.

EXAMINATION OF PUBLIC WATER SUPPLIES.

EXAMINATION OF PUBLIC WATER SUPPLIES.

The usual chemical analyses of the principal sources of public water supply in the State have been made during the year and are presented in the two following tables, the first of which contains averages of analyses of the surface-water supplies and the second the averages of analyses of the ground-water supplies.

Averages of Chemical Analyses of Surface-water Sources for the Year 1911.

[Parts in 100,000.]

CITY OR TOWN.	Source.	Color.	Residue on Evaporation.	AMMONIA.			Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
				Free.	ALBUMINOID.			Nitrates.	Nitrites.		
					Total.	Suspended.					
Metropolitan Water District.	Wachusett Reservoir, upper end.	.24	3.42	.0020	.0143	.0027	.29	.0021	.0000	.39	0.9
	Wachusett Reservoir, lower end.	.09	2.94	.0015	.0112	.0017	.26	.0007	.0000	.23	0.9
	Sudbury Reservoir,	.10	3.38	.0020	.0141	.0024	.30	.0017	.0000	.23	1.2
	Framingham Reservoir, No. 3.	.11	3.26	.0030	.0143	.0033	.29	.0013	.0000	.28	1.3
	Hopkinton Reservoir,	.39	4.07	.0025	.0176	.0018	.40	.0016	.0000	.55	1.2
	Ashland Reservoir,	.49	4.18	.0022	.0224	.0035	.37	.0014	.0000	.64	1.3
	Framingham Reservoir, No. 2.	.62	4.90	.0041	.0242	.0026	.42	.0030	.0001	.77	1.4
	Lake Cochituate,	.13	5.97	.0021	.0199	.0041	.65	.0005	.0001	.34	2.4
	Chestnut Hill Reservoir,	.27	3.80	.0024	.0160	.0027	.33	.0015	.0000	.38	1.3
	Weston Reservoir,	.09	3.24	.0021	.0133	.0023	.30	.0010	.0000	.24	1.3
	Spot Pond,	.11	3.53	.0018	.0144	.0027	.36	.0008	.0000	.28	1.4
	Tap in State House,	.24	3.96	.0014	.0151	.0026	.36	.0026	.0000	.34	1.3
	Tap in Revere,	.16	3.48	.0016	.0134	.0021	.35	.0007	.0000	.23	1.3
	Tap in Quincy,	.21	3.90	.0013	.0129	.0010	.36	.0032	.0000	.32	1.5
Abington,	Big Sandy Pond,	.08	3.98	.0038	.0155	.0019	.72	.0008	.0000	.19	0.7
	Little Sandy Pond,	.03	3.61	.0051	.0124	.0031	1.20	.0007	.0000	.17	0.6
Adams,	Dry Brook,	.17	7.28	.0034	.0078	.0009	.13	.0127	.0001	.28	4.9
	Bassett Brook,	.06	4.22	.0027	.0054	.0011	.13	.0120	.0001	.14	3.0
Amherst,	Amethyst Brook large reservoir.	.67	3.98	.0044	.0172	.0026	.18	.0010	.0000	.78	0.9
	Amethyst Brook small reservoir.	.27	2.65	.0019	.0125	.0023	.23	.0050	.0000	.44	0.9
	Lower Reservoir,	.36	3.77	.0045	.0159	.0035	.19	.0018	.0000	.49	1.0
Andover,	Haggett's Pond,	.09	3.83	.0019	.0167	.0018	.40	.0005	.0000	.29	1.3

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
				Free.	Albuminoid.			Nitrates.	Nitrites.		
					Total.	Suspended.					
Ashfield.	Bear Swamp Brook,	.29	4.78	.0019	.0144	.0022	.13	.0017	.0000	.45	2.7
Athol,	Phillipston Reservoir,	.45	3.60	.0067	.0391	.0157	.21	.0030	.0000	.67	0.9
	Buckman Brook Reservoir.	.29	3.77	.0047	.0218	.0060	.17	.0037	.0000	.49	1.0
Barre,	Reservoir,	.22	4.37	.0075	.0340	.0125	.20	.0052	.0001	.40	1.4
Blandford,	Freeland Brook,	.06	3.69	.0067	.0043	.0007	.16	.0137	.0000	.11	2.0
Brockton,	Silver Lake,	.08	3.45	.0028	.0174	.0034	.68	.0004	.0000	.20	0.6
Cambridge,	Upper Hobbs Brook Reservoir.	.45	6.97	.0093	.0349	.0071	.52	.0105	.0002	.70	2.8
	Lower Hobbs Brook Reservoir.	.11	6.07	.0045	.0271	.0051	.48	.0011	.0001	.34	2.4
	Stony Brook Reservoir,	.38	6.76	.0047	.0265	.0045	.59	.0065	.0001	.57	2.5
	Fresh Pond,	.24	6.80	.0080	.0268	.0086	.64	.0121	.0004	.43	2.9
Cheshire,	Thunder Brook,	.01	10.40	.0036	.0060	.0012	.15	.0040	.0000	.12	7.9
	Kitchen Brook,	.00	7.50	.0008	.0030	.0002	.10	.0050	.0000	.08	5.7
Chester,	Austin Brook,	.05	2.95	.0008	.0048	.0006	.16	.0020	.0000	.20	1.7
Chicopee,	Morton Brook,	.15	4.15	.0002	.0026	.0002	.14	.0000	.0000	.10	1.1
	Cooley Brook,	.52	5.25	.0022	.0092	.0016	.15	.0000	.0002	.50	1.1
Concord,	Nagog Pond,	.04	2.61	.0009	.0182	.0067	.33	.0007	.0000	.15	0.6
Dalton,	Egypt Brook Reservoir,	.30	3.65	.0018	.0103	.0008	.10	.0072	.0000	.47	1.2
Danvers,	Middleton Pond,	.36	4.95	.0018	.0184	.0020	.49	.0005	.0000	.59	1.9
Deerfield,	Roaring Brook,	.18	7.25	.0006	.0046	.0004	.16	.0020	.0000	.15	4.2
Fall River,	North Watuppa Lake,	.12	4.18	.0025	.0174	.0025	.71	.0010	.0000	.28	1.1
Falmouth,	Long Pond,	.02	3.41	.0015	.0121	.0017	1.00	.0000	.0000	.12	0.3
Fitchburg,	Meetinghouse Pond,	.10	3.30	.0026	.0176	.0026	.21	.0018	.0000	.21	0.9
	Scott Reservoir,	.15	3.50	.0034	.0243	.0076	.26	.0038	.0000	.34	0.7
	Wachusett Lake,	.10	3.27	.0058	.0248	.0112	.20	.0005	.0000	.17	0.9
Gardner,	Crystal Lake,	.07	5.40	.0027	.0139	.0020	.30	.0027	.0000	.22	2.3
Gloucester,	Dike's Brook Reservoir,	.26	4.34	.0063	.0162	.0035	1.13	.0020	.0000	.35	0.5
	Wallace Reservoir,	.44	5.28	.0031	.0225	.0049	1.35	.0005	.0000	.51	0.5
	Haskell Brook Reservoir,	.68	4.92	.0053	.0166	.0032	1.11	.0012	.0001	.47	0.6
Great Barrington,	East Mountain Reservoir,	.12	5.69	.0035	.0132	.0028	.14	.0012	.0001	.23	3.5
	Green River,	.04	8.89	.0013	.0055	.0005	.16	.0158	.0001	.10	7.4
Greenfield,	Glen Brook Upper Reservoir.	.08	6.30	.0017	.0093	.0019	.18	.0025	.0000	.15	3.4
	Glen Brook Lower Reservoir.	.11	5.59	.0018	.0099	.0032	.17	.0028	.0001	.16	3.2

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

CITY OR TOWN.	Source.	Color.	Residue on Evaporation.	AMMONIA.			Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
					ALBUMINOID.						
				Free.	Total.	Suspended.		Nitrates.	Nitrites.		
Hadley,	Hart's Brook Reservoir,	.12	4.50	.0030	.0086	.0022	.20	.0007	.0000	.20	2.0
Hatfield,	Running Gutter Brook Reservoir.	.20	4.94	.0020	.0084	.0014	.16	.0102	.0000	.29	2.0
Haverhill,	Johnson's Pond,	.14	4.65	.0016	.0170	.0014	.46	.0010	.0000	.31	2.2
	Crystal Lake,	.17	4.14	.0013	.0164	.0016	.38	.0012	.0000	.35	1.6
	Kenosa Lake,	.16	4.72	.0023	.0190	.0021	.44	.0008	.0000	.41	2.1
	Lake Saltonstall,	.12	5.32	.0019	.0169	.0021	.53	.0005	.0000	.29	2.4
	Lake Pentucket,	.17	4.24	.0016	.0167	.0020	.42	.0010	.0000	.36	2.1
	Millvale Reservoir,	.46	5.32	.0030	.0234	.0040	.40	.0015	.0000	.66	1.9
Hingham,	Accord Pond,	.10	4.07	.0023	.0108	.0017	.76	.0038	.0001	.24	0.8
Holden,	Muschopauge Lake,	.09	3.16	.0015	.0129	.0016	.32	.0010	.0000	.17	1.1
Holyoke,	Whiting Street Reservoir,	.16	4.79	.0035	.0180	.0028	.23	.0005	.0001	.25	2.6
	Fomer Reservoir,	.31	4.13	.0020	.0100	.0015	.17	.0023	.0000	.42	1.6
	Wright and Ashley Pond,	.14	4.62	.0031	.0200	.0041	.20	.0007	.0001	.29	2.4
	High Service Reservoir,	.15	4.12	.0026	.0286	.0056	.20	.0007	.0000	.38	2.1
Hudson,	Gates Pond,	.09	3.46	.0037	.0169	.0020	.27	.0013	.0000	.24	1.1
	Fosgate Brook,	.52	10.82	.0061	.0280	.0020	.24	.0875	.0003	.84	3.9
Huntington,	Cold Brook Reservoir,	.19	2.80	.0008	.0072	.0007	.14	.0007	.0000	.29	1.0
Ipswich,	Dow's Brook Reservoir,	.19	5.40	.0033	.0191	.0038	.78	.0022	.0001	.41	2.0
Lawrence,	Merrimack River, filtered.	.39	7.47	.0088	.0129	–	.54	.0333	.0003	.42	1.8
Lee,	Codding Brook Upper Reservoir.	.24	4.05	.0025	.0116	.0018	.13	.0043	.0000	.37	1.6
	Codding Brook Lower Reservoir.	.25	4.45	.0019	.0107	.0013	.14	.0040	.0000	.40	2.3
	Basin Pond Brook,	.42	4.72	.0020	.0130	.0012	.13	.0060	.0000	.59	2.1
Lenox,	Reservoir,	.11	7.74	.0031	.0085	.0021	.13	.0055	.0000	.17	5.8
Leominster,	Morse Reservoir,	.25	3.00	.0049	.0249	.0052	.25	.0022	.0001	.39	0.4
	Haynes Reservoir,	.29	3.09	.0092	.0404	.0136	.23	.0019	.0001	.42	0.4
	Fall Brook Reservoir,	.10	2.51	.0021	.0150	.0030	.22	.0009	.0000	.22	0.5
Lincoln,	Sandy Pond,	.02	5.12	.0059	.0154	.0033	.37	.0004	.0000	.15	2.0
Longmeadow,	Cooley Brook,	.12	4.72	.0015	.0050	.0006	.23	.0150	.0004	.19	2.8
Lynn,	Birch Reservoir,	.36	5.57	.0063	.0258	.0036	.76	.0022	.0001	.56	2.1
	Breed's Reservoir,	.30	5.39	.0073	.0231	.0042	.76	.0019	.0001	.53	1.9
	Walden Reservoir,	.53	6.00	.0084	.0269	.0040	.76	.0026	.0001	.66	2.4
	Hawkes Reservoir,	.98	8.30	.0085	.0425	.0078	.93	.0030	.0001	1.17	3.2
	Saugus River,	1.33	10.15	.0080	.0437	.0042	1.00	.0006	.0001	1.42	4.6

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

CITY OR TOWN.	Source.	Color.	Residue on Evaporation.	AMMONIA.			Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
				Free.	ALBUMINOID.			Nitrates.	Nitrites.		
					Total.	Suspended.					
Manchester, . .	Round Pond, . .	.65	6.30	.0052	.0282	.0035	1.05	.0008	.0001	.73	1.4
	Gravel Pond, . .	.08	3.97	.0021	.0139	.0021	.91	.0013	.0000	.20	1.0
Marlborough, .	Lake Williams, . .	.10	4.55	.0030	.0183	.0024	.58	.0008	.0001	.21	1.7
	Millham Brook Reservoir.	.37	4.90	.0056	.0250	.0056	.43	.0061	.0001	.51	1.8
Maynard, . .	White Pond, . . .	.09	3.18	.0008	.0095	.0009	.30	.0035	.0000	.17	1.1
Milford, . .	Charles River, filtered, .	.22	3.97	.0014	.0080	–	.39	.0077	.0000	.31	1.2
Montague, . .	Lake Pleasant, . .	.10	3.22	.0057	.0088	.0009	.18	.0032	.0001	.21	0.9
Nantucket, . .	Wannacomet Pond, .	.12	6.64	.0027	.0189	.0090	2.15	.0001	.0000	.17	1.5
New Bedford, .	Little Quittacas Pond, .	.25	3.78	.0021	.0181	.0017	.61	.0002	.0000	.44	1.0
	Great Quittacas Pond, .	.32	3.56	.0028	.0223	.0024	.62	.0003	.0000	.55	0.8
North Adams, .	Notch Brook Reservoir,	.08	6.38	.0012	.0089	.0020	.10	.0008	.0000	.17	5.3
	Broad Brook, . .	.15	3.55	.0019	.0100	.0024	.11	.0112	.0001	.27	2.0
Northampton, .	Middle Reservoir, . .	.36	4.50	.0047	.0171	.0032	.23	.0020	.0000	.51	1.7
	Mountain Street Reservoir.	.14	4.41	.0030	.0127	.0030	.15	.0007	.0000	.26	2.0
	West Brook, . . .	.10	4.47	.0011	.0057	.0007	.14	.0057	.0000	.19	2.1
North Andover, .	Great Pond, . . .	.13	4.11	.0020	.0163	.0023	.45	.0017	.0000	.23	1.6
Northborough, .	Lower Reservoir, . .	.66	4.82	.0025	.0287	.0074	.31	.0013	.0000	.80	1.3
Northbridge, .	Cook Allen Reservoir, .	.19	3.03	.0033	.0159	.0042	.32	.0012	.0000	.32	0.7
North Brookfield,	Doane Pond, . .	.37	3.55	.0072	.0180	.0031	.16	.0030	.0002	.36	1.1
	North Pond, . .	.59	4.12	.0050	.0320	.0107	.19	.0023	.0001	.67	0.8
Norwood, . .	Buckmaster Pond, .	.09	6.18	.0448	.0175	.0082	.77	.0028	.0001	.12	1.9
Orange, . .	Distributing Reservoir, .	.12	3.48	.0019	.0057	.0012	.17	.0010	.0001	.18	0.9
Palmer, . .	Lower Reservoir, . .	.21	3.36	.0040	.0117	.0020	.18	.0020	.0000	.21	0.9
Peabody, . .	Brown's Pond, . .	.12	4.22	.0032	.0173	.0019	.90	.0017	.0000	.30	1.3
	Spring Pond, . . .	.19	7.19	.0090	.0161	.0038	.78	.0063	.0002	.25	2.9
	Suntaug Lake, . .	.08	5.02	.0031	.0171	.0025	.90	.0003	.0000	.19	2.5
Pittsfield, . .	Ashley Lake, . . .	.18	5.86	.0040	.0144	.0013	.16	.0040	.0001	.36	4.0
	Ashley Brook, . .	.21	7.15	.0037	.0114	.0015	.17	.0064	.0001	.36	5.1
	Hathaway Brook, . .	.12	8.63	.0013	.0077	.0020	.14	.0146	.0000	.19	6.7
	Mill Brook, . . .	.23	6.49	.0050	.0119	.0030	.16	.0044	.0001	.28	3.7
	Sacket Brook, . .	.09	7.07	.0037	.0064	.0012	.15	.0104	.0000	.15	5.5
Plymouth, . .	Little South Pond, .	.01	2.89	.0022	.0148	.0023	.73	.0007	.0000	.12	0.2
	Great South Pond, .	.01	2.86	.0020	.0129	.0020	.69	.0007	.0000	.13	0.2

Averages of Chemical Analyses of Surface-water Sources, etc. — Concluded.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.						
				Free.	Total.	Suspended.		Nitrates.	Nitrites.		
Randolph, . .	Great Pond, . . .	.42	5.29	.0021	.0213	.0022	.81	.0024	.0001	.62	1.5
Rockport, . .	Cape Pond, . . .	.30	11.64	.0027	.0259	.0068	4.61	.0002	.0000	.24	2.3
Russell, . .	Black Brook, . . .	.22	4.14	.0018	.0086	.0010	.17	.0028	.0001	.29	1.5
Salem, . . .	Wenham Lake, . .	.22	7.25	.0080	.0257	.0089	1.05	.0042	.0004	.40	2.7
	Longham Reservoir, .	1.16	8.67	.0082	.0407	.0080	1.19	.0076	.0002	1.30	2.4
Southbridge, .	Hatchet Brook Reservoir No. 3.	.24	3.62	.0043	.0200	.0045	.25	.0026	.0000	.40	1.0
	Hatchet Brook Reservoir No. 4.	.32	3.20	.0070	.0205	.0045	.24	.0017	.0001	.43	0.8
South Hadley, .	Leaping Well Reservoir,	.10	3.04	.0140	.0218	.0080	.20	.0018	.0000	.16	0.9
	Buttery Brook Reservoir.	.16	4.34	.0074	.0115	.0037	.28	.0169	.0002	.17	0.9
Spencer, . .	Shaw Pond, . . .	.05	2.80	.0007	.0147	.0013	.21	.0007	.0000	.20	1.0
Springfield, . .	Westfield Little River, filtered.	.18	4.24	.0015	.0082	–	.16	.0086	.0000	–	1.4
Stockbridge, .	Lake Averic, . .	.12	6.87	.0075	.0252	.0061	.14	.0015	.0001	.31	4.6
Taunton, . .	Assawompsett Pond, .	.16	3.92	.0021	.0179	.0020	.60	.0005	.0000	.36	0.7
	Elder's Pond, . .	.10	3.65	.0021	.0181	.0024	.60	.0002	.0000	.27	0.7
Wakefield, . .	Crystal Lake, . .	.15	5.27	.0058	.0223	.0061	.75	.0027	.0001	.26	2.1
Wareham (Onset),	Jonathan Pond, . .	.02	2.45	.0010	.0071	.0008	.70	.0006	.0000	.09	0.2
Wayland, . .	Snake Brook Reservoir, .	.79	6.07	.0055	.0303	.0045	.44	.0047	.0001	.99	1.8
Westfield, . .	Montgomery Reservoir, .	.47	3.03	.0070	.0212	.0036	.19	.0010	.0000	.64	0.5
	Tekoa Reservoir, . .	.36	3.05	.0020	.0157	.0032	.17	.0016	.0000	.48	0.6
	Tillotson Brook Reservoir.	.18	3.52	.0021	.0099	.0026	.18	.0010	.0000	.28	0.7
West Springfield, .	Darby Brook Reservoir,	.27	6.18	.0038	.0171	.0062	.31	.0036	.0001	.38	3.1
	Bear Hole Brook, filtered,	.14	7.54	.0022	.0053	–	.22	.0077	.0000	–	4.9
Weymouth, . .	Great Pond, . . .	.37	4.31	.0025	.0165	.0018	.66	.0007	.0000	.46	1.0
Williamsburg, .	Reservoir, . . .	.18	4.44	.0016	.0089	.0013	.18	.0012	.0000	.26	1.7
Winchester, . .	North Reservoir, . .	.13	4.24	.0027	.0253	.0051	.53	.0002	.0000	.27	1.7
	South Reservoir, . .	.09	3.48	.0059	.0158	.0030	.47	.0019	.0001	.20	1.5
	Middle Reservoir, . .	.26	3.90	.0097	.0301	.0069	.49	.0023	.0001	.36	1.3
Worcester, . .	Bottomly Reservoir, .	.20	4.90	.0103	.0216	.0058	.24	.0150	.0001	.38	1.9
	Kent Reservoir, . .	.19	4.26	.0030	.0184	.0039	.30	.0080	.0001	.36	1.5
	Leicester Reservoir, .	.19	4.31	.0047	.0179	.0027	.29	.0042	.0001	.38	1.6
	Mann Reservoir, . .	.14	3.84	.0050	.0182	.0043	.25	.0088	.0000	.31	1.6
	Upper Holden Reservoir,	.29	3.52	.0064	.0237	.0113	.22	.0034	.0000	.39	0.8
	Lower Holden Reservoir,	.18	2.87	.0052	.0155	.0029	.22	.0032	.0000	.30	0.7

Averages of Chemical Analyses of Ground-water Sources for the Year 1911.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.		
Adams, . . .	Tubular wells, ...	.04	13.20	.0000	.0008	.13	.0360	.0000	11.1	.0035
Amesbury, . .	Tubular wells, ...	.06	12.00	.0004	.0018	.61	.0005	.0000	6.1	.0275
Attleborough, . .	Large well, ...	.02	5.16	.0006	.0043	.55	.0146	.0000	2.1	.0037
Avon, ...	Wells, ...	.01	5.37	.0005	.0027	.56	.0817	.0000	1.6	.0177
Ayer, ...	Large well, ...	.00	6.80	.0001	.0014	.98	.0418	.0000	2.4	.0065
	Tubular wells, ...	.01	4.97	.0005	.0010	.21	.0025	.0000	2.1	.0223
Bedford, . . .	Large well, ...	.05	4.27	.0011	.0025	.38	.0026	.0000	1.5	.0192
Billerica, . . .	Tubular wells, ...	.13	6.10	.0018	.0039	.40	.0012	.0000	2.2	.0450
Braintree, . .	Filter-gallery, ...	.02	6.58	.0025	.0050	1.23	.0530	.0000	2.3	.0058
Bridgewater, . .	Wells, ...	.14	9.97	.0005	.0048	.55	.0045	.0000	4.1	.0428
Brookfield (East), .	Tubular wells, ...	.00	3.06	.0004	.0012	.20	.0087	.0000	0.4	.0066
Brookline, . .	Tubular wells and filter-gallery.	.22	9.61	.0062	.0065	.76	.0218	.0003	4.9	.0546
Canton, . . .	Springdale well, ...	.05	5.02	.0002	.0018	.48	.0208	.0000	1.5	.0170
	Well near Henry's Spring, .	.03	4.64	.0002	.0019	.50	.0276	.0000	1.6	.0072
Chelmsford (North),	Tubular wells, ...	.23	4.50	.0084	.0067	.41	.0142	.0002	1.8	.1012
Chicopee (Fairview),	Tubular wells, ...	.04	3.99	.0003	.0010	.12	.0012	.0000	0.8	.0219
Cohasset, . .	Tubular wells No. 2, . .	.00	15.20	.0003	.0029	2.14	.1512	.0000	6.5	.0028
	Filter-gallery, ...	.40	13.81	.1976	.0145	1.33	.0004	.0002	6.1	.0696
	Large well, ...	.41	7.76	.0063	.0130	1.39	.0039	.0001	2.1	.0697
Dedham, . . .	Large well and tubular wells,	.01	10.01	.0015	.0041	1.04	.1336	.0000	4.3	.0089
Douglas, . . .	Tubular wells, ...	.05	3.87	.0008	.0012	.35	.0302	.0001	1.6	.0227
Dracut (Water supply District).	Tubular wells, ...	.01	9.08	.0002	.0009	.46	.0447	.0001	4.6	.0131
Dracut (Collinsville),	Tubular wells, ...	.04	12.15	.0007	.0029	.37	.0250	.0000	5.6	.0065
Dudley, . . .	Tubular wells, ...	.00	3.59	.0004	.0018	.26	.0028	.0000	1.1	.0047
Easthampton, .	Tubular wells, ...	.01	8.37	.0002	.0009	.14	.0235	.0000	3.7	.0044
Easton, . . .	Well, ...	.01	4.90	.0003	.0023	.62	.0447	.0000	1.6	.0060
Edgartown, . .	Tubular wells, ...	.00	3.60	.0004	.0011	.93	.0010	.0000	0.4	.0053
Fairhaven, . .	Tubular wells, ...	.45	7.63	.0008	.0096	1.21	.0548	.0000	2.4	.0077
Foxborough, . .	Tubular wells, ...	.00	4.57	.0010	.0009	.41	.0383	.0000	1.0	.0033
Framingham, . .	Filter-gallery, ...	.03	10.57	.0119	.0071	1.24	.0177	.0000	4.9	.0142
Franklin, . .	Tubular wells, ...	.00	4.16	.0003	.0011	.40	.0314	.0000	1.2	.0054
Grafton, . . .	Filter-gallery, ...	.05	10.70	.0034	.0036	1.15	.1450	.0001	4.3	.0160
Granville, . .	Well, ...	.12	6.20	.0006	.0027	.14	.0122	.0004	2.4	.0265
Groton, . . .	Large well, ...	.00	5.93	.0004	.0017	.21	.0017	.0000	3.3	.0050

Averages of Chemical Analyses of Ground-water Sources, etc. — Continued.

[Parts in 100,000.]

CITY OR TOWN.	Source.	Color.	Residue on Evaporation.	AMMONIA.		Chlorine.	NITROGEN AS		Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.		
Hingham,	Wells,	.14	6.05	.0148	.0072	.78	.0080	.0004	1.9	.0105
Hopkinton,	Tubular wells,	.01	14.40	.0002	.0015	1.34	.3833	.0000	5.8	.0057
Hyde Park,	Tubular Wells near Neponset River.	.19	16.61	.0252	.0053	2.49	.0585	.0002	6.5	.0801
	Tubular wells near Mother Brook.	.16	11.04	.0010	.0080	1.20	.1454	.0000	4.2	.0064
Kingston,	Tubular wells,	.02	3.72	.0003	.0012	.75	.0028	.0000	1.1	.0120
Leicester,	Wells,	.06	6.65	.0002	.0042	.32	.0687	.0000	2.7	.0077
Lowell,	Boulevard wells (tubular),	.48	6.32	.0431	.0072	.39	.0066	.0001	2.6	.2379
Manchester,	Large well,	.00	11.47	.0004	.0016	1.98	.1650	.0000	4.0	.0095
Mansfield,	Large well,	.00	4.10	.0003	.0013	.47	.0443	.0000	1.3	.0038
Marblehead,	Wells Nos. 1 and 2,	.04	44.48	.0004	.0021	12.45	.0152	.0000	16.7	.0182
	Well No. 2, filtered,	.00	20.64	.0006	.0025	2.03	.0067	.0000	10.1	.0040
Marion,	Tubular wells,	.00	4.30	.0003	.0009	.76	.0222	.0000	1.1	.0042
Marshfield,	Well,	.00	40.05	.0003	.0011	13.72	.1350	.0000	8.6	.0035
Medfield,	Spring,	.02	3.80	.0000	.0010	.37	.0000	.0000	1.3	.0050
Merrimac,	Tubular wells,	.05	6.45	.0009	.0014	.55	.0290	.0000	2.6	.0295
Methuen,	Tubular wells,	.31	7.86	.0026	.0102	.42	.0060	.0000	3.2	.0357
Middleborough,	Well,	.33	5.90	.0049	.0060	.69	.0367	.0000	2.3	.1598
Millbury,	Well,	.00	6.00	.0002	.0028	.41	.0212	.0000	2.6	.0070
Millis,	Spring,	.00	9.20	.0000	.0006	.69	.1300	.0000	3.1	.0050
Monson,	Large well,	.00	3.53	.0004	.0016	.17	.0147	.0000	1.2	.0037
Natick,	Large well,	.00	8.94	.0002	.0021	.68	.0232	.0000	4.7	.0040
Needham,	Well No. 1,	.00	6.82	.0002	.0021	.78	.1200	.0000	2.6	.0027
	Well No. 2,	.00	6.25	.0004	.0019	.76	.1075	.0000	2.5	.0035
	Hick's Spring,	.01	4.83	.0004	.0024	.57	.0945	.0000	1.7	.0027
Newburyport,	Wells and springs,	.06	8.03	.0013	.0066	.99	.0141	.0000	3.1	.0191
Newton,	Tubular wells and filter-gallery.	.02	6.37	.0006	.0031	.48	.0233	.0000	2.5	.0043
No. Attleborough,	Wells,	.00	6.57	.0002	.0017	.58	.0278	.0000	2.6	.0057
Oak Bluffs,	Springs,	.01	3.89	.0006	.0016	1.01	.0131	.0000	0.7	.0119
Oxford,	Tubular wells,	.00	4.48	.0001	.0009	.33	.0417	.0000	1.6	.0040
Palmer (Bondsville),	Tubular wells,	.00	4.62	.0003	.0011	.16	.0080	.0000	1.7	.0067
Pepperell,	Tubular wells,	.00	3.64	.0003	.0013	.20	.0006	.0000	1.4	.0037
Plainville,	Tubular wells,	.06	5.42	.0003	.0012	.34	.0007	.0000	2.1	.0563
Provincetown,	Tubular wells in Truro,	.00	7.29	.0004	.0011	2.69	.0044	.0000	1.5	.0115

Averages of Chemical Analyses of Ground-water Sources, etc. — Concluded.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.		
Reading, . . .	Filter-gallery, ...	.84	13.49	.0227	.0180	3.50	.0041	.0001	3.0	.2500
	Filtered water, ...	.28	21.20	.0130	.0116	3.55	.0055	.0004	9.4	.0237
Scituate, . . .	Tubular wells, ...	.01	17.16	.0002	.0022	3.57	.2229	.0000	6.2	.0039
Sharon, . . .	Well, ...	.00	11.00	.0002	.0012	1.39	.2300	.0000	4.4	.0079
Sheffield, . .	Spring, ...	.00	3.27	.0003	.0011	.09	.0053	.0000	1.6	.0057
Shirley, . . .	Well, ...	.00	3.77	.0004	.0013	.30	.0410	.0000	0.9	.0046
Tisbury, . . .	Well, ...	.05	4.13	.0006	.0010	.98	.0013	.0000	0.6	.0457
Uxbridge, . .	Tubular wells, ...	.00	5.35	.0005	.0010	.59	.0790	.0000	1.8	.0040
Walpole, . . .	Tubular wells, ...	.00	4.37	.0003	.0012	.42	.0382	.0000	1.6	.0043
Waltham, . .	Old well, ...	.09	8.60	.0025	.0033	.86	.0237	.0000	3.7	.0387
	New well, ...	.00	8.23	.0008	.0029	.66	.0197	.0000	3.7	0039
Ware, . . .	Wells, ...	.00	5.28	.0004	.0010	.29	.0587	.0000	1.9	.0037
Wareham (Fire District).	Tubular wells, ...	.00	3.68	.0007	.0012	.61	.0012	.0000	0.9	.0045
Webster, . .	Wells, ...	.00	4.56	.0004	.0016	.33	.0094	.0000	1.8	.0092
Wellesley, . .	Tubular wells, ...	.00	9.14	.0002	.0014	.99	.0628	.0000	4.2	.0043
	Well at Williams Spring, .	.00	13.50	.0018	.0017	1.26	.5450	.0000	5.0	.0039
Westborough, . .	Filter basin, ...	.01	2.93	.0017	.0106	.29	.0003	.0000	1.2	.0072
Westford, . .	Tubular wells, ...	.00	3.86	.0002	.0007	.18	.0046	.0000	1.3	.0032
Weston, . . .	Well, ...	.20	9.54	.0013	.0104	.59	.0195	.0000	3.5	.0065
Winchendon, . .	Well, ...	.19	3.63	.0017	.0028	.14	.0040	.0000	0.7	.1077
Woburn, . . .	Wells, ...	.00	10.75	.0015	.0041	1.49	.0195	.0000	4.8	.0047
Wrentham, . .	Tubular wells, ...	.00	3.19	.0002	.0010	.34	.0032	.0000	1.0	.0037

EXAMINATION OF RIVERS.

EXAMINATION OF RIVERS.

All of the larger rivers of the State are polluted in a greater or less degree by the sewage of cities or towns or by manufacturing wastes from factories and mills located upon their banks, and to some extent from other causes incident to regions as populous as are most of the river valleys of Massachusetts. In some cases the pollution is slight and detectable only by analysis unless in the immediate vicinity of the outlet of a sewer or below a factory or mill discharging wastes from manufacturing processes in which the water used is more or less fouled. In other cases the pollution caused by the discharge of sewage or manufacturing waste at a city, town or village is so great that the river has an objectionable appearance and a noticeable odor for a long distance; and in some cases the pollution is so great as to render the stream filthy and offensive for many miles.

The year 1911 was one of the driest on record up to the end of the summer season. Toward the end of August the rainfall increased, and in the latter part of the year was greater than the average. The effect of these conditions upon the condition of the streams was to diminish their flow during the warmer part of the year, and reduce the dilution of sewage and other pollutions to a lower point even than in the previous year. In the latter part of the year, however, the higher rainfall afforded a greater dilution than in the previous year, and the effect of pollution was much less noticeable.

On nearly all of the important streams of the State stations were established many years ago at which samples of the water have been collected for chemical examination to determine the changes taking place from time to time in the condition of the water. The samples are for the most part collected during the six drier months of the year, from June to November inclusive, since in that part of the year the dilution of sewage in polluted streams is least and the effect of pollution most noticeable. In a few cases samples are collected monthly throughout the year. During the year 1911 chemical analyses were made of samples of water collected from the following streams at monthly intervals, in some cases during the entire year: —

Assabet.
Blackstone.
Charles.
Chicopee.
Concord.
Connecticut.
Deerfield.
French.
Green.
Hoosick.
Housatonic.
Merrimack.
Mill (Northampton).
Miller's.
Nashua.
Nemasket.
Neponset.
Quaboag.
Quinebaug.
Salisbury Plain.
Shawsheen.
Sudbury.
Taunton.
Ten Mile.
Ware.
Westfield.

BLACKSTONE RIVER.

A general statement of the condition of this river in the year 1911 will be found on page 28.

BLACKSTONE RIVER.

CHEMICAL EXAMINATION OF WATER FROM BLACKSTONE RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Blackstone River, below Cherry Valley.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1908, . . .	-	20.57	3.83	.1531	.0624	.0508	.0116	5.76	.0020	.0007	-	-
1909, . . .	.35	13.93	3.34	.0681	.0470	.0334	.0136	3.70	.0125	.0003	.80	-
1910, . . .	.32	16.42	3.92	.0633	.0489	.0387	.0102	4.02	.0146	.0002	.85	-
1911, . . .	-	21.02	4.40	.1277	.0726	.0559	.0167	5.70	.0080	.0005	1.15	-

BLACKSTONE RIVER.

CHEMICAL EXAMINATION OF WATER FROM BLACKSTONE RIVER, ETC. — *Continued.*

Blackstone River, between Mill Brook Channel and the Sewage Precipitation Works of the City of Worcester.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
					Albuminoid.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
1887,	0.91	–	–	.2686	.1741	–	–	1.35	.0160	–	–
1888,	0.76	–	–	.2658	.1112	.0557	.0555	1.50	.0382	.0041	–
1889,	0.86	–	–	.3980	.1430	.0772	.0658	1.32	.0177	.0026	–
1890,	1.14	9.92	3.03	.2107	.1246	.0673	.0573	1.07	.0250	.0015	2.9
1891,	1.10	17.42	5.59	.4913	.1950	.1127	.0823	2.29	.0192	.0037	5.0
1892,	0.52	20.75	6.30	.3547	.1433	.0708	.0725	2.43	.0227	.0108	6.1
1893,	0.40	16.98	4.55	.1480	.0588	.0240	.0348	1.01	.0115	.0015	6.3
1894,	0.66	16.93	4.76	.0548	.0380	.0236	.0144	0.74	.0115	.0005	4.4
1895,	0.49	14.17	4.50	.0613	.0414	.0243	.0171	0.92	.0163	.0006	3.4
1896,	0.51	12.90	2.93	.0780	.0415	.0282	.0133	0.97	.0147	.0015	3.4
1897,	0.85	26.45	7.68	.1130	.0674	.0362	.0312	0.89	.0090	.0024	4.2
1898,	0.33	17.42	5.62	.0857	.0619	.0260	.0359	0.96	.0053	.0010	4.6
1899,	0.14	34.38	10.60	.2583	.0788	.0390	.0398	–	–	.0004	14.3
1900,	0.05	16.48	3.38	.1068	.0518	.0210	.0308	1.03	.0107	.0012	3.6
1901,	0.23	31.03	11.68	.1410	.0548	.0309	.0239	–	–	.0023	13.8
1902,	0.10	46.15	12.47	.2453	.0728	.0274	.0454	–	–	.0010	16.5
1903,	0.18	24.06	6.80	.2836	.0750	.0472	.0278	–	–	.0027	8.4
1904,	0.12	44.68	17.08	.1228	.0434	.0225	.0209	–	–	.0008	14.7
1905,	0.21	50.36	19.49	.0952	.0492	.0203	.0289	–	–	.0003	29.3
1906,	0.11	40.07	15.25	.0688	.0421	.0189	.0232	–	.0032	.0002	20.3
1907,	0.04	44.07	17.67	.0613	.0343	.0180	.0163	–	–	.0003	–
1908,	0.16	23.67	5.55	.0990	.0291	.0153	.0138	3.23	.0134	.0014	–
1909,	–	52.97	18.55	.1865	.0381	.0239	.0142	4.80	.0033	.0010	–
1910,	0.15	50.92	18.97	.1933	.0545	.0309	.0236	4.07	.0023	.0009	–
1911,	0.11	44.64	15.70	.1920	.0449	.0212	.0237	4.03	.0170	.0009	–

Blackstone River, below Sewage Precipitation Works.

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
					Albuminoid.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
1887,	0.91	–	–	.2686	.1741	–	–	1.35	.0160	–	–
1888,	0.76	–	–	.2658	.1112	.0557	.0555	1.50	.0382	.0041	–
1889,	0.86	–	–	.3980	.1430	.0772	.0658	1.32	.0177	.0026	–
1890,	0.97	11.36	3.10	.2907	.1492	.0722	.0770	1.46	.0270	.0018	3.9
1891,	1.05	22.25	6.60	.6367	.1508	.0883	.0625	2.61	.0233	.0040	6.2
1892,	0.63	26.80	7.75	.5240	.1810	.0958	.0852	3.13	.0137	.0050	10.3
1893,	0.51	30.00	7.13	.5680	.1453	.0900	.0553	2.76	.0285	.0126	10.9
1894,	0.40	29.30	5.86	.6189	.1390	.1113	.0277	2.63	.0212	.0071	10.6
1895,	0.71	22.15	5.18	.3246	.0898	.0597	.0301	1.86	.0267	.0063	7.3
1896,	0.30	26.03	6.53	.2831	.0898	.0600	.0298	2.10	.0217	.0118	9.7
1897,	0.73	25.98	4.97	.3650	.1122	.0782	.0340	1.61	.0207	.0063	6.9
1898,	0.23	25.63	6.73	.3064	.0868	.0560	.0308	1.55	.0132	.0119	9.2
1899,	0.14	44.02	9.67	.5251	.1707	.0912	.0795	3.26	.0108	.0068	16.1
1900,	0.22	24.57	4.48	.4430	.1249	.0621	.0628	2.13	.0110	.0145	7.3
1901,	0.09	31.12	6.90	.4580	.1293	.0772	.0521	3.42	.0090	.0058	10.8
1902,	0.15	49.62	13.38	.7296	.1284	.0736	.0548	2.97	–	.0033	12.5
1903,	0.39	31.08	9.48	.3880	.1080	.0545	.0535	–	–	.0062	10.4
1904,	–	50.25	13.73	.6381	.1523	.0601	.0922	–	–	.0027	16.9
1905,	0.19	59.84	17.97	.4936	.0985	.0597	.0388	–	–	.0008	29.3
1906,	0.19	49.69	11.42	.6330	.1818	.0580	.1238	–	.0058	.0130	15.0
1907,	0.37	40.40	7.87	.7600	.0837	.0580	.0257	5.15	.0255	.0061	–
1908,	0.46	37.70	6.82	1.1317	.1362	.0919	.0443	6.80	.0078	.0040	–
1909,	–	48.82	9.29	1.2200	.1072	.0777	.0295	8.20	.0140	.0069	–
1910,	–	52.38	11.13	1.3033	.1265	.0892	.0373	8.07	.0108	.0046	–
1911,	0.20	48.98	7.93	1.2633	.1150	.0709	.0441	8.88	.0255	.0123	–

BLACKSTONE RIVER.

CHEMICAL EXAMINATION OF WATER FROM BLACKSTONE RIVER, ETC. — *Concluded.*

Blackstone River, at Uxbridge.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
					Albuminoid.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
1887,	.39	–	–	.1129	.0271	–	–	0.79	.0360	–	–
1888,	.38	6.42	1.52	.1155	.0288	.0222	.0066	0.68	.0310	.0007	–
1889,	.32	–	–	.1133	.0296	.0192	.0104	0.66	.0333	.0009	–
1890,	.26	8.86	2.12	.1629	.0231	.0174	.0057	0.79	.0259	.0005	2.9
1891,	.20	10.16	2.61	.2280	.0175	.0117	.0058	1.04	.0425	.0007	3.6
1892,	.13	9.36	1.88	.2840	.0227	.0162	.0065	0.99	.0313	.0007	3.1
1893,	.24	11.74	2.37	.1985	.0207	.0140	.0067	1.20	.0623	.0050	4.2
1894,	.35	13.07	2.03	.1456	.0243	.0183	.0060	1.57	.0673	.0050	4.9
1895,	.56	12.95	2.69	.0906	.0258	.0182	.0076	1.34	.0631	.0065	4.7
1896,	.33	12.68	2.67	.1129	.0257	.0221	.0036	1.38	.0477	.0091	5.0
1897,	.48	11.60	2.47	.1029	.0280	.0215	.0065	1.32	.0652	.0051	4.3
1898,	.49	10.59	2.78	.0801	.0264	.0219	.0045	1.00	.0470	.0076	3.8
1899,	.18	18.34	3.11	.2490	.0359	.0310	.0049	2.17	.0510	.0141	7.4
1900,	.19	13.42	2.04	.2260	.0347	.0257	.0090	1.76	.0558	.0060	5.0
1901,	.22	13.91	2.67	.3159	.0285	.0240	.0045	1.50	.0195	.0035	5.0
1902,	.15	14.17	2.56	.3462	.0270	.0218	.0052	1.95	.0210	.0018	4.9
1903,	.30	13.16	2.52	.3030	.0262	.0215	.0047	1.74	.0210	.0024	4.4
1904,	.20	13.78	2.74	.2399	.0282	.0214	.0068	2.12	.0408	.0022	4.6
1905,	.21	16.34	2.55	.3928	.0246	.0203	.0043	2.65	.0175	.0025	5.0
1906,	.19	14.73	3.10	.2218	.0242	.0200	.0042	2.10	.0252	.0009	4.2
1907,	.37	14.23	2.58	.2331	.0238	.0182	.0056	2.36	.0330	.0040	4.5
1908,	.31	16.33	4.07	.2387	.0253	.0196	.0057	3.05	.0408	.0071	–
1909,	.22	18.31	4.35	.3473	.0273	.0216	.0057	3.64	.0325	.0066	–
1910,	.26	22.53	4.69	.4963	.0356	.0302	.0054	4.62	.0498	.0043	–
1911,	.26	23.10	3.85	.3717	.0293	.0225	.0068	4.15	.0558	.0173	–

Blackstone River, at Millville.

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
1887,	.31	–	–	.0468	.0220	–	–	0.51	.0210	–	–
1888,	.41	5.22	1.40	.0467	.0296	.0233	.0063	0.50	.0278	.0004	–
1889,	.38	–	–	.0499	.0273	.0213	.0060	0.45	.0167	.0003	–
1890,	.26	6.71	2.24	.0736	.0196	.0152	.0044	0.53	.0229	.0003	2.3
1891,	.24	7.48	2.35	.1105	.0384	.0234	.0150	0.72	.0308	.0006	2.2
1892,	.37	6.70	1.62	.1143	.0294	.0210	.0084	0.63	.0217	.0002	2.0
1893,	.23	7.43	1.73	.0677	.0119	.0087	.0032	0.77	.0385	.0011	2.6
1894,	.47	8.42	2.16	.0510	.0172	.0139	.0033	0.89	.0273	.0012	2.8
1895,	.51	8.67	2.55	.0356	.0233	.0180	.0053	0.90	.0383	.0024	3.2
1896,	.35	8.53	1.69	.0484	.0237	.0180	.0057	0.97	.0413	.0027	3.3
1897,	.45	7.66	1.98	.0509	.0258	.0210	.0048	0.92	.0445	.0019	3.1
1898,	.51	7.12	2.17	.0325	.0240	.0193	.0047	0.63	.0240	.0023	2.5
1899,	.20	12.50	2.44	.1310	.0301	.0247	.0054	1.31	.0310	.0049	4.6
1900,	.29	9.33	1.82	.1168	.0254	.0219	.0035	1.15	.0417	.0039	3.4
1901,	.31	8.62	2.13	.1420	.0288	.0227	.0061	0.87	.0155	.0006	3.1
1902,	.28	9.43	2.24	.1623	.0284	.0238	.0046	1.20	.0195	.0010	2.8
1903,	.33	8.46	1.85	.1397	.0233	.0189	.0044	1.10	.0192	.0010	2.9
1904,	.29	8.71	2.06	.1079	.0235	.0201	.0034	1.26	.0337	.0009	2.9
1905,	.28	10.76	2.03	.1956	.0311	.0222	.0089	1.67	.0207	.0008	2.9
1906,	.37	9.02	2.15	.1526	.0306	.0251	.0055	1.27	.0188	.0006	2.4
1907,	.37	10.43	2.21	.1521	.0240	.0181	.0059	1.61	.0247	.0014	3.1
1908,	.33	9.85	2.53	.1295	.0232	.0185	.0047	1.78	.0258	.0024	3.4
1909,	.24	11.87	3.17	.1595	.0267	.0220	.0047	2.27	.0225	.0019	–
1910,	.30	13.94	3.32	.2350	.0277	.0234	.0043	3.01	.0290	.0013	–
1911,	.33	14.35	2.79	.1787	.0268	.0222	.0046	2.94	.0355	.0051	–

NOTE. — The sewage purification works of the city of Worcester were put in operation in 1890, since which time a portion of the sewage of the city has been treated. The works were enlarged in 1893 and since that time practically all of the dry-weather flow of sewage has been treated.

CHARLES RIVER.

A general statement of the condition of this river in the year 1911 will be found on page 28.

CHARLES RIVER.

CHEMICAL EXAMINATION OF WATER FROM CHARLES RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Charles River, above Milford.

[Parts in 100,000.]

YEAR.		Residue on Evaporation.		Ammonia.					Nitrogen as			
					Albuminoid.							
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Hardness.
1899,	.28	3.98	1.70	.0017	.0248	.0223	.0025	.27	.0027	.0003	.48	0.6
1900,	.49	3.93	1.67	.0017	.0251	.0231	.0020	.25	.0030	.0000	.64	0.5
1901,	.46	4.30	2.48	.0066	.0286	.0247	.0039	.25	.0060	.0002	.65	0.6
1902,	.58	4.42	1.90	.0025	.0248	.0210	.0038	.29	.0057	.0001	.70	1.1
1903,[1]	.55	4.17	1.86	.0015	.0203	.0171	.0032	.28	.0080	.0001	.68	0.8
1904,[2]	.49	3.95	1.83	.0117	.0267	.0209	.0058	.33	.0035	.0001	.62	1.1
1905,[3]	.55	3.77	1.62	.0020	.0229	.0201	.0028	.31	.0033	.0001	.56	0.8
1906,[3]	.62	4.05	1.90	.0032	.0257	.0230	.0027	.30	.0073	.0001	.68	0.6
1907,	.43	3.79	1.59	.0020	.0198	.0173	.0025	.32	.0047	.0001	.48	0.8
1908,	.36	3.11	1.43	.0023	.0198	.0171	.0027	.33	.0025	.0001	.42	0.5
1909,	.31	3.52	1.62	.0030	.0207	.0176	.0031	.32	.0012	.0000	.39	0.7
1910,	.37	3.47	1.34	.0042	.0231	.0204	.0027	.37	.0011	.0001	.46	0.8
1911,	.40	3.94	1.48	.0036	.0210	.0183	.0027	.42	.0007	.0000	.56	1.1

[1] October omitted.
[2] Two months.
[3] Three months.

Charles River, below Milford.

YEAR.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Hardness.
1898,	.63	10.47	3.08	.1196	.0597	.0422	.0175	2.47	.0473	.0064	.69	2.4
1899,	.50	12.52	3.12	.3487	.1345	.0803	.0542	3.00	.0053	.0008	1.12	2.6
1900.	.56	12.85	2.65	.7123	.0764	.0563	.0201	2.74	.0140	.0055	.93	3.1
1901,	.63	9.52	3.37	.1419	.0451	.0317	.0134	1.40	.0422	.0048	.86	2.6
1902,	.52	10.74	3.38	.2118	.0658	.0406	.0252	2.21	.0236	.0049	1.02	2.7
1903,[1]	.49	9.03	2.85	.2237	.0479	.0277	.0202	1.36	.0396	.0050	.66	2.5
1904,[2]	.50	9.20	2.94	.2105	.0508	.0350	.0158	1.44	.0513	.0055	.63	2.6
1906,[3]	.68	8.76	2.90	.1536	.0568	.0427	.0141	1.64	.0160	.0012	.92	2.0
1907,	.54	12.95	2.83	.4607	.0864	.0525	.0339	2.94	.0852	.0021	.86	3.2
1908,	.48	10.81	3.48	.3925	.0598	.0347	.0251	1.79	.0218	.0049	.64	–
1909,	.50	12.66	4.07	.5658	.0479	.0399	.0080	1.89	.0273	.0064	.72	–
1910,	.57	15.21	3.83	.8038	.0640	.0499	.0141	3.01	.0248	.0082	.88	4.2
1911,	.58	14.12	3.64	.2881	.0447	.0323	.0124	2.51	.0785	.0114	.75	4.4

[1] November omitted.
[2] Four months.
[3] June omitted.

CHARLES RIVER.

CHEMICAL EXAMINATION OF WATER FROM CHARLES RIVER, ETC. — *Concluded.*

Charles River, opposite Pumping Station of Brookline Water Works.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1887, . . .	.83	5.37	1.62	.0013	.0282	–	–	.44	.0087	–	–	–
1888, . . .	.98	4.87	1.92	.0014	.0264	.0240	.0024	.37	.0062	.0002	–	–
1895, . . .	.74	4.91	2.08	.0004	.0237	.0207	.0030	.48	.0055	.0001	.75	1.5
1897, . . .	1.02	5.36	2.45	.0012	.0288	.0262	.0026	.43	.0067	.0001	.86	1.5
1898, . . .	.87	5.22	2.40	.0012	.0303	.0281	.0022	.39	.0035	.0001	.92	1.4
1899, . . .	.46	5.03	1.92	.0011	.0262	.0230	.0032	.45	.0025	.0001	.62	1.5
1900, . . .	.56	4.96	1.60	0018	.0252	.0229	.0023	.46	.0020	.0000	.70	1.4
1901, . . .	.92	5.45	2.60	.0020	.0314	.0275	.0039	.41	.0047	.0001	.95	1.4
1902, . . .	.52	5.46	2.03	.0031	.0234	.0211	.0023	.57	.0045	.0001	.64	1.6
1903, . . .	.71	6.22	2.30	.0031	.0240	.0223	.0017	.53	.0065	.0001	.80	1.5
1904, . . .	.51	5.24	2.17	.0021	.0224	.0208	.0016	.55	.0060	.0001	.67	1.6
1905,[1] . . .	.84	5.93	2.60	.0029	.0318	.0277	.0041	.54	.0056	.0002	.92	1.5
1906,[1] . . .	1.05	6.00	2.77	.0039	.0294	.0267	.0027	.53	.0032	.0001	1.17	1.4
1907,[1] . . .	.63	6.15	2.40	.0022	.0246	.0228	.0018	.64	.0026	.0001	.73	1.7
1908,[1] . . .	.55	5.93	2.29	.0035	.0248	.0222	.0026	.65	.0036	.0002	.61	1.7
1909,[2] . . .	.65	5.75	2.00	.0023	.0254	.0236	.0018	.69	.0015	.0001	.75	1.5
1910, . . .	.60	6.71	2.79	.0028	.0289	.0260	.0029	.83	.0013	.0001	.72	1.8
1911, . . .	.85	7.42	3.02	.0040	.0302	.0258	.0044	.80	.0032	.0001	1.10	2.0

[1] Five months. [2] Two months.

Charles River, opposite Pumping Station of Waltham Water Works.

1887, . . .	.67	6.02	1.62	.0029	.0274	–	–	.48	.0043	–	–	–
1888, . . .	.82	5.47	1.88	.0035	.0310	.0265	.0045	.41	.0087	.0002	–	–
1897, . . .	.95	6.06	2.45	.0056	.0322	.0299	.0023	.53	.0073	.0002	.83	1.9
1898, . . .	.81	5.74	2.46	.0050	.0329	.0296	.0033	.44	.0043	.0001	.85	1.6
1899, . . .	.41	5.50	1.81	.0047	.0264	.0248	.0016	.51	.0051	.0002	.52	1.9
1900, . . .	.52	5.93	1.68	.0064	.0282	.0259	.0023	.53	.0070	.0002	.58	1.7
1901, . . .	.82	5.93	2.72	.0065	.0322	.0289	.0033	.44	.0067	.0002	.85	1.8
1902, . . .	.45	6.21	1.97	0084	.0258	.0228	.0030	.62	.0077	.0003	.59	2.0
1903, . . .	.64	6.06	2.21	.0078	.0267	.0230	.0028	.58	0084	.0003	.71	2.0
1904, . . .	.55	6.08	2.22	0062	.0317	.0266	.0051	.62	0095	.0002	.62	2.0
1905, . . .	.79	6.29	2.54	.0077	.0363	.0308	.0055	.58	0075	.0002	.80	1.7
1906, . . .	1.00	6.70	2.58	.0063	.0335	.0297	.0038	.59	.0038	.0002	.98	1.8
1907,[1] . . .	.58	6.22	2.24	.0067	.0278	.0247	.0031	.63	.0058	.0002	.65	2.0
1908, . . .	.62	6.50	2.49	.0048	.0344	.0284	.0060	.69	.0027	.0001	.64	1.9
1909, . . .	.54	6.79	2.36	.0063	.0349	.0298	.0051	.76	.0026	.0002	.53	2.0
1910, . . .	.59	7.37	2.87	.0078	.0336	.0299	.0037	.81	.0037	.0003	.56	2.4
1911, . . .	.75	7.47	2.95	.0086	.0343	.0308	.0035	.85	.0030	.0003	.87	2.3

[1] July omitted.

CHICOPEE RIVER.

A general statement of the condition during the year 1911 of the Ware, Swift and Quaboag rivers, tributaries of the Chicopee River, will be found on pages 33 and 34.

CHICOPEE RIVER.

CHEMICAL EXAMINATION OF WATER FROM CHICOPEE RIVER AND ITS TRIBUTARIES. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Ware River, below Ware.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1898,	.64	4.42	1.94	.0028	.0332	.0250	.0082	.19	.0025	.0003	.77	1.0
1899,	.46	4.82	1.77	.0052	.0371	.0268	.0103	.25	.0015	.0004	.66	0.9
1900,	.51	4.93	1.64	.0066	.0321	.0243	.0078	.25	.0030	.0003	.73	1.1
1901,	.78	4.79	2.15	.0082	.0300	.0242	.0058	.18	.0044	.0002	.84	1.3
1902,	.76	4.86	2.17	.0071	.0348	.0252	.0096	.23	.0040	.0003	.93	1.0
1903,[1]	.68	4.83	2.18	.0072	.0345	.0240	.0105	.25	.0034	.0003	.78	0.8
1904,[1]	.60	5.60	2.36	.0043	.0411	.0285	.0126	.29	.0046	.0004	.72	1.1
1908,	.56	7.38	2.86	.0265	.0418	.0264	0154	.37	.0033	.0005	.80	–
1909,[1]	.61	8.63	3.05	.0354	.0569	.0357	.0212	.44	.0015	.0006	.98	–
1910,	.57	9.82	4.39	0655	.0622	.0426	.0196	.60	.0040	.0011	.84	–
1911,	.70	9.15	3.37	.0396	.0554	.0375	.0179	.48	.0015	.0003	.98	–

[1] September omitted.

Quaboag River, below Palmer.

1899,	.35	4.54	1.68	.0048	.0252	.0208	.0044	.26	.0060	.0002	.44	1.1
1900,	.40	4.56	1.58	.0038	.0218	.0176	.0042	.26	.0062	.0001	.48	1.2
1901,	.42	4.32	1.74	.0043	.0255	.0202	.0053	.23	.0052	.0002	.53	1.1
1902,	.41	4.55	1.64	0077	.0242	.0196	.0046	.33	.0085	.0002	.53	1.2
1903,	.44	4.36	1.67	.00[illegible]0	.0242	.0186	.0056	.27	.0092	.0033	.51	1.0
1904,	.40	4.68	1.70	.0191	.0253	.0195	.0058	.31	.0082	.0002	.50	1.1
1908,	.36	5.31	1.98	.0061	.0207	.0149	.0058	.40	.0070	.0003	.42	–
1909,	.31	5.43	1.95	.0068	.0211	.0165	.0046	.41	.0058	.0003	.47	–
1910,	.44	6.05	2.28	.0043	.0238	.0168	.0070	.52	.0057	.0003	.73	–
1911,[1]	.39	5.94	2.08	.0060	.0191	.0145	.0046	.44	.0032	.0002	.53	–

[1] Four months.

Swift River, below Bondsville.

1908,[1]	.34	5.45	2.42	.0047	.0217	.0132	.0085	.21	.0013	.0002	.44	–
1909,[2]	.40	4.60	1.[illegible]0	.0016	.01[illegible]6	.0139	.005	.22	.0000	.0001	.60	–
1910,	.33	5.28	2.05	0031	.0261	0196	.0065	.25	.0010	.0001	.60	–
1911,	.48	5.05	2.12	.0021	.0278	.0193	.0085	.21	.0007	.0000	.74	–

[1] Three months. [2] Two months.

Chicopee River, at Indian Orchard.

1908,[1]	.42	5.21	1.98	.0100	.0240	.0177	0063	.33	.0056	.0003	.62	–
1909,[1]	.38	5.82	2.08	.0094	.0220	.0162	0058	.36	.0046	.0004	.46	–
1910,	.45	6.14	2.06	.0099	.0239	0191	0048	.44	.0052	.0003	.50	–
1911,	.48	6.12	2.10	.0081	.0275	0184	0091	.42	.0067	.0004	.57	–

[1] Five months.

CONCORD RIVER.

A general statement of the condition during the year 1911 of the Assabet and Sudbury rivers, tributaries of the Concord River, will be found on pages 27 and 32.

CONCORD RIVER.

CHEMICAL EXAMINATION OF WATER FROM CONCORD RIVER AND ITS TRIBUTARIES. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Sudbury River, below Saxonville.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1901,	.84	7.22	3.37	.0073	.0624	.0431	.0193	.38	.0050	.0005	1.05	1.9
1902,	.38	6.39	2.57	.0150	.0424	.0272	.0152	.60	.0103	.0005	.55	2.2
1903,	.52	7.77	2.78	.0028	.0549	.0296	.0253	.65	.0080	.0002	.83	2.1
1904,	.48	9.58	3.57	.0569	.0587	.0385	.0202	.87	.0193	.0032	.88	2.5
1906,[1]	.67	6.88	2.90	.0258	.0525	.0381	.0144	.56	.0058	.0004	.92	1.9
1907,[2]	.65	9.07	3.28	.1357	.0653	.0347	.0306	.84	.0063	.0004	.84	2.1
1908,[3]	.44	9.67	3.72	.0039	.0634	.0374	.0260	1.06	.0128	.0009	.69	–
1909,	.43	6.81	2.59	.0174	.0330	.0256	.0074	.64	.0043	.0005	.64	–
1910,	.49	9.78	3.45	.0454	.0606	.0345	.0261	.83	.0040	.0010	.65	–
1911,	.37	9.03	3.08	.0287	.0410	.0281	.0129	.92	.0120	.0009	.54	–

[1] June omitted.

[2] Three months.

[3] August omitted.

Assabet River, above Westborough.

1909,	.56	6.01	2.20	.0048	.0217	.0194	.0023	.36	.0015	.0001	.69	–
1910,	.90	7.37	3.12	.0029	.0251	.0229	.0022	.38	.0035	.0001	.86	–
1911,	.97	8.02	3.39	.0061	.0441	.0354	.0087	.45	.0023	.0002	1.20	–

Assabet River, below Westborough.

1909,	1.70	19.24	8.91	.4140	.2281	.1616	.0665	1.94	.0005	.0005	2.90	–
1910,	2.23	17.07	7.00	.2898	.1334	.1018	.0316	2.16	.0078	.0018	2.20	–
1911,	.83	12.09	4.01	.0556	.0460	.0373	.0087	1.87	.0967	.0121	1.24	–

Assabet River, above Hudson.

1908,[1]	.49	5.97	2.16	.0044	.0241	.0200	.0041	.54	.0072	.0003	.59	–
1909,	.39	6.37	2.33	.0070	.0306	.0261	.0045	.52	.0037	.0002	.50	–
1910,	.57	6.90	3.08	.0058	.0346	.0296	.0050	.61	.0055	.0002	.67	–
1911,	.57	6.82	2.51	.0059	.0295	.0248	.0047	.57	.0077	.0002	.81	–

[1] September omitted.

CONCORD RIVER.

CHEMICAL EXAMINATION OF WATER FROM CONCORD RIVER AND ITS TRIBUTARIES, ETC. — *Concluded.*

Assabet River, below Hudson.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1898, ...	.79	5.61	2.38	.0062	.0335	.0291	.0044	.39	.0063	.0003	.87	1.6
1899, ...	.50	8.30	3.01	.0205	.0457	.0383	.0074	.80	.0020	.0004	.73	2.1
1900, ...	.48	8.06	2.05	.0382	.0501	.0362	.0139	1.27	.0028	.0007	.72	2.0
1901, ...	.66	5.47	2.38	.0193	.0375	.0295	.0080	.79	.0107	.0005	.91	1.8
1902, ...	.64	7.06	2.69	.0189	.0464	.0330	.0134	.84	.0077	.0005	.74	1.9
1903,[1]	.51	5.71	2.17	.0092	.0287	.0222	.0065	.56	.0073	.0006	.60	1.7
1904,[2]	.44	7.67	2.60	.0329	.0375	.0312	.0063	1.43	.0073	.0005	.64	1.9
1908, ...	.51	9.17	3.50	.0198	.0396	.0294	.0102	1.32	.0072	.0005	.82	–
1909, ...	.51	8.81	3.26	.0161	.0403	.0296	.0107	.98	.0022	.0002	.64	–
1910, ...	.69	13.83	3.83	.0413	.0428	.0337	.0091	1.27	.0048	.0002	1.24	–
1911, ...	.64	12.83	4.30	.0817	.0532	.0400	.0132	.90	.0043	.0003	1.36	–

[1] June omitted.

[2] Three months.

Assabet River, above Maynard.

1904, ...	.53	5.65	2.30	.0046	.0275	.0231	.0044	.64	.0035	.0001	.63	1.6
1906, ...	.75	5.53	2.26	.0065	.0290	.0254	.0036	.48	.0035	.0002	.97	1.5
1907,[1]	.68	5.35	1.80	.0047	.0255	.0211	.0044	.50	.0043	.0002	.73	1.6
1908, ...	.52	6.91	2.32	.0093	.0288	.0248	.0040	1.03	.0030	.0002	.62	–
1909, ...	.43	6.18	2.13	.0068	.0343	.0277	.0066	.72	.0023	.0001	.62	–
1910, ...	.54	7.70	2.82	.0098	.0337	.0291	.0046	.98	.0017	.0003	.64	–
1911, ...	.57	7.67	2.33	.0087	.0327	.0277	.0050	.85	.0065	.0004	.73	–

[1] Four months.

Assabet River, below Maynard.

1898, ...	.77	5.93	2.59	.0020	.0387	.0301	.0086	.43	.0030	.0003	.89	1.5
1899, ...	.51	6.70	2.21	.0185	.0414	.0327	.0087	.73	.0043	.0003	.62	1.7
1900, ...	.50	5.72	1.73	.0217	.0386	.0304	.0082	.70	.0031	.0002	.59	1.4
1901, ...	.73	6.57	2.67	.0211	.0428	.0351	.0077	.45	.0052	.0002	.90	1.6
1902, ...	.69	7.27	2.87	.0099	.0592	.0381	.0211	.57	.0033	.0002	.83	1.6
1903, ...	.61	6.40	2.58	.0170	.0457	.0322	.0135	.48	.0037	.0003	.83	1.6
1904, ...	–	8.48	3.21	.0143	.0678	.0412	.0266	.74	.0043	.0002	1.05	1.7
1906, ...	.88	6.68	2.64	.0290	.0448	.0312	.0136	.58	.0047	.0003	.91	1.6
1907,[1]	.79	7.64	2.76	.0299	.0391	.0274	.0117	.69	.0060	.0003	.86	1.6
1908, ...	.45	11.46	3.98	.0675	.0684	.0381	.0303	1.37	.0028	.0012	.89	–
1909, ...	–	13.97	4.21	.1208	.0991	.0529	.0462	1.22	.0007	.0006	1.34	–
1910, ...	.59	13.15	4.68	.0708	.0685	.0446	.0239	1.82	.0038	.0006	.85	–
1911, ...	.58	12.73	4.17	.0738	.0650	.0408	.0242	1.41	.0060	.0006	1.08	–

[1] Four months.

Concord River, at Billerica.

1902, ...	.68	5.98	2.18	.0091	.0347	.0272	.0075	.53	.0052	.0004	.78	1.7
1903, ...	.64	5.71	2.26	.0097	.0317	.0258	.0059	.49	.0058	.0005	.72	1.8
1904, ...	.64	6.05	2.31	.0077	.0341	.0255	.0086	.55	.0072	.0002	.75	1.7
1908, ...	.37	8.04	2.65	.0107	.0251	.0216	.0035	.96	.0104	.0005	.54	–
1909, ...	.49	7.71	2.78	.0128	.0298	.0267	.0031	.75	.0058	.0013	.65	–
1910, ...	.49	7.31	3.00	.0142	.0325	.0292	.0033	1.01	.0055	.0004	.58	–
1911, ...	.45	11.14	4.05	.0181	.0525	.0287	.0238	1.16	.0132	.0008	1.14	–

CONNECTICUT RIVER.

A general statement of the condition of this river during the year 1911 will be found on page 28.

CONNECTICUT RIVER.

CHEMICAL EXAMINATION OF WATER FROM CONNECTICUT RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Connecticut River, above Holyoke.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1904, . . .	.29	5.98	2.21	.0018	.0171	.0130	.0041	.15	.0050	.0002	.73	2.9
1906,[1] . . .	.35	6.70	2.59	.0036	.0231	.0188	.0043	.19	.0026	.0001	.77	3.2
1907,[2] . . .	.35	5.58	1.89	.0027	.0200	.0144	.0056	.19	.0048	.0002	.66	2.5
1908,[3] . . .	.30	8.04	2.78	.0071	.0196	.0143	.0053	.29	.0030	.0001	.80	-
1909, . . .	.33	8.66	2.92	.0036	.0196	.0140	.0056	.22	.0020	.0001	.89	-
1910, . . .	.36	8.80	3.15	.0042	.0183	.0143	.0040	.21	.0035	.0002	.76	-
1911, . . .	.34	7.90	3.05	.0067	.0188	.0138	.0050	.23	.0008	.0002	.87	-

[1] November omitted. [2] Four months. [3] June omitted.

Connecticut River, below Springfield.

1888, . . .	.35	5.34	1.24	.0032	.0182	.0143	.0039	.15	.0082	.0002	-	-
1899, . . .	.33	6.61	1.99	.0093	.0238	.0195	.0043	.23	.0042	.0003	.67	3.1
1900, . . .	.44	6.64	1.90	.0098	.0250	.0176	.0074	.20	.0034	.0002	.89	3.1
1901, . . .	.32	6.03	2.34	.0061	.0190	.0153	.0037	.18	.0048	.0003	.65	3.0
1902, . . .	.31	5.83	2.13	.0062	.0180	.0140	.0040	.16	.0055	.0005	.61	3.0
1903, . . .	.30	6.12	2.04	.0098	.0202	.0147	.0055	.24	.0058	.0004	.61	2.7
1904,[1] . . .	.22	5.22	1.87	.0098	.0187	.0125	.0062	.21	.0047	.0002	.48	2.4
1906,[2] . . .	.35	7.14	2.61	.0082	.0204	.0161	.0043	.24	.0026	.0004	.71	2.8
1907,[3] . . .	.38	6.27	2.46	.0069	.0163	.0131	.0032	.24	.0050	.0003	.67	2.9
1908, . . .	.32	8.58	2.61	.0214	.0223	.0165	.0058	.38	.0040	.0004	.81	-
1909, . . .	.29	6.02	2.25	.0079	.0156	.0118	.0038	.22	.0018	.0003	.65	-
1910, . . .	.33	8.67	3.60	.0155	.0241	.0188	.0053	.37	.0028	.0003	.89	-
1911, . . .	.38	7.66	2.56	.0140	.0181	.0147	.0034	.28	.0018	.0005	.70	-

[1] Three months. [2] June omitted. [3] Four months.

DEERFIELD RIVER.

A general statement of the condition of this river in the year 1911 will be found on page 34.

DEERFIELD RIVER.

CHEMICAL EXAMINATION OF WATER FROM DEERFIELD RIVER AND TRIBUTARY. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Deerfield River, at Deerfield.

[Parts in 100,000.]

YEAR.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1901,[1]	.23	4.35	1.58	.0011	.0121	.0109	.0012	.10	.0080	.0001	.38	2.1
1903,[2]	.21	4.15	1.47	.0012	.0106	.0093	.0013	.10	.0088	.0001	.34	1.9
1904,	.31	4.29	1.52	.0021	.0144	.0115	.0029	.11	.0040	.0001	.47	1.9

[1] Three months.

[2] June omitted.

Green River, below Greenfield.

YEAR.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Hardness.
1903,	.05	7.75	2.23	.0152	.0143	.0086	.0057	.21	.0078	.0005	.15	3.9
1904,	.07	6.93	2.01	.0151	.0382	.0138	.0244	.28	.0100	.0006	.22	3.8
1908,	.17	11.06	2.97	.0665	.0337	.0131	.0206	.45	.0043	.0011	.33	-
1909,	.14	7.82	2.54	.0459	.0333	.0151	.0182	.37	.0038	.0011	.23	-
1910,	.17	8.33	3.16	.0775	.0284	.0169	.0115	.37	.0025	.0012	.23	-
1911,	.21	9.23	2.44	.0684	.0228	.0115	.0113	.48	.0033	.0014	.37	-

FRENCH RIVER.

A general statement of the condition of this river in the year 1911 will be found on page 29.

FRENCH RIVER.

CHEMICAL EXAMINATION OF WATER FROM FRENCH RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

French River, below Webster.

[Parts in 100,000.]

YEAR.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1899,	.44	5.67	2.07	.0238	.0612	.0384	0228	.42	.0024	.0007	.66	1.6
1900,	.52	5.79	2.10	.0202	.0475	0357	0118	.46	.0062	.0007	.78	1.5
1901,	.50	5.29	2.25	.0090	.0390	.0265	0125	.33	.0044	.0002	.75	1.2
1902,	.42	4.92	1.99	.0057	.0391	.0264	0127	.39	.0038	.0002	.65	1.2
1903,	.48	4.67	1.88	.0049	.0352	.0241	.0111	.40	.0058	.0002	.72	0.9
1904,	.44	6.02	2.18	.0267	.0434	.0281	0153	.58	.0042	.0004	.70	1.3
1906,	.61	5.08	2.19	.0063	.0353	.0246	.0107	.40	.0038	.0003	.81	0.9
1907,[1]	.54	6.28	2.62	.0117	.0544	.0304	.0240	.49	.0035	.0004	.69	1.2
1908,	.44	7.17	2.82	.0086	.0507	.0310	.0197	.61	.0037	.0010	.81	-
1909,	.50	7.42	2.61	.0267	.0638	.0385	.0253	.77	.0055	.0012	.72	-
1910,	.44	8.27	3.55	.0512	.0527	.0321	.0206	.78	.0016	.0021	.79	-
1911,	.57	10.23	3.17	.0219	.0652	.0405	.0247	.89	.0015	.0001	.94	-

[1] Four months.

HOOSICK RIVER.

A general statement of the condition of this river in the year 1911 will be found on page 29.

HOOSICK RIVER.

CHEMICAL EXAMINATION OF WATER FROM HOOSICK RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Hoosick River, at Williamstown.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1887, ...	.22	12.05	1.22	.0065	.0190	–	–	.23	.0232	–	–	–
1888, ...	.12	10.82	1.90	.0026	.0210	.0142	.0068	.27	.0247	.0015	–	–
1894, ...	.37	13.56	2.74	.0166	.0361	.0224	.0137	.50	.0102	.0014	.42	9.0
1895, ...	.34	14.20	3.26	.0190	.0424	.0241	.0183	.63	.0090	.0020	.53	9.0
1896, ...	.21	11.71	2.39	.0295	.0267	.0172	.0095	.39	.0133	.0018	.33	8.6
1897, ...	.26	11.32	2.39	.0174	.0312	.0173	.0139	.30	.0265	.0011	.31	7.9
1898, ...	.27	10.46	2.38	.0223	.0311	.0210	.0101	.31	.0170	.0007	.34	6.6
1899, ...	.30	15.21	3.31	.0252	.0622	.0379	.0243	.64	.0070	.0029	.62	8.3
1900, ...	.28	14.20	2.79	.0433	.0547	.0301	.0246	.60	.0087	.0043	.58	7.8
1901, ...	.27	13.02	3.70	.0400	.0520	.0250	.0270	.43	.0152	.0024	.53	7.3
1902, ...	.22	10.62	2.87	.0069	.0307	.0172	.0135	.34	.0123	.0014	.40	6.4
1903, ...	.17	10.50	2.37	.0272	.0264	.0151	.0113	.29	.0183	.0019	.33	7.5
1904, ...	.13	12.30	3.23	.0677	.0310	.0191	.0119	.45	.0203	.0024	.29	8.3
1905, ...	.20	11.09	2.81	.0295	.0265	.0156	.0109	.32	.0123	.0015	.31	5.6
1906, ...	.31	13.28	3.63	.0415	.0489	.0252	.0237	.47	.0147	.0030	.43	6.0
1907, ...	.25	11.80	2.93	.0431	.0390	.0231	.0159	.47	.0135	.0021	.39	7.9
1908, ...	.23	14.00	3.86	.0559	.0323	.0195	.0128	.54	.0085	.0023	.37	–
1909, ...	.23	15.46	4.09	.0496	.0382	.0243	.0139	.62	.0060	.0035	.41	–
1910, ...	.30	13.06	4.43	.0320	.0336	.0219	.0117	.52	.0102	.0018	.41	–
1911, ...	.26	12.38	3.77	.1153	.0492	.0232	.0260	.58	.0065	.0022	.43	–

HOUSATONIC RIVER.

A general statement of the condition of this river in the year 1911 will be found on page 30.

HOUSATONIC RIVER.

CHEMICAL EXAMINATION OF WATER FROM HOUSATONIC RIVER AND ITS BRANCHES. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

East Branch, below Pittsfield.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1903, ...	.32	9.75	2.92	.0118	.0226	.0153	.0073	.25	.0142	.0006	.56	6.8
1904,[1]	.28	9.02	3.15	.0117	.0248	.0175	.0073	.26	.0113	.0005	.47	6.2
1907,[2]	.42	9.40	3.00	.0286	.0284	.0186	.0098	.28	.0060	.0010	.50	6.4
1908,[3]	.29	12.76	3.57	.0327	.0250	.0177	.0073	.40	.0140	.0011	.47	–
1909, ...	.26	12.60	4.37	.0431	.0305	.0215	.0090	.33	.0087	.0007	.44	–
1910, ...	.30	12.98	5.26	.0437	.0233	.0182	.0051	.40	.0080	.0012	.48	–
1911,[1]	.29	12.03	4.26	.0231	.0253	.0169	.0084	.37	.0060	.0011	.54	–

[1] Three months. [2] Two months. [3] November omitted.

HOUSATONIC RIVER.

CHEMICAL EXAMINATION OF WATER FROM HOUSATONIC RIVER AND ITS BRANCHES, ETC. — *Concluded.*

West Branch, below Pittsfield.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1903, . . .	.29	10.43	2.83	.0100	.0210	.0148	.0067	.23	.0143	.0006	.46	7.4
1904,[1] . . .	.15	12.27	3.50	.0137	.0423	.0217	.0206	.35	.0050	.0004	.35	7.8
1908,[2] . . .	.20	13.28	3.68	.0210	.0301	.0194	.0107	.26	.0026	.0009	.36	–
1909, . . .	–	11.00	2.87	.0070	.0283	.0175	.0108	.24	.0010	.0003	.25	–
1910, . . .	.22	13.85	4.98	.0218	.0446	.0218	.0228	.40	.0012	.0011	.40	–
1911,[1] . . .	.19	12.73	4.70	.0090	.0317	.0184	.0133	.26	.0030	.0005	.37	–

[1] Three months.

[2] November omitted.

South-west Branch, at Pittsfield.

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1899, . . .	.17	14.92	2.58	.0040	.0353	.0211	.0142	.16	.0108	.0004	.37	9.2
1900, . . .	.14	14.87	2.15	.0192	.0335	.0229	.0106	.21	.0107	.0008	.35	10.2
1901, . . .	.14	13.20	3.87	.0051	.0302	.0197	.0105	.16	.0096	.0004	.41	9.4
1902, . . .	.11	12.30	3.09	.0057	.0224	.0136	.0088	.12	.0108	.0005	.37	8.7
1903, . . .	.10	11.63	2.37	.0045	.0162	.0109	.0053	.11	.0115	.0003	.25	8.8
1904,[1] . . .	.15	12.45	3.63	.0116	.0455	.0223	.0232	.34	.0040	.0018	.35	7.8
1907,[2] . . .	.31	10.78	2.30	.0040	.0258	.0168	.0090	.20	.0025	.0003	.39	8.2
1908,[3] . . .	.18	15.17	4.89	.0216	.0269	.0159	.0110	.23	.0036	.0007	.38	–
1909, . . .	.17	14.82	4.41	.0041	.0265	.0153	.0112	.23	.0082	.0005	.37	–
1910, . . .	.17	14.45	5.25	.0049	.0196	.0135	.0061	.17	.0045	.0006	.30	–
1911,[1] . . .	.14	12.62	3.35	.0013	.0224	.0131	.0093	.19	.0110	.0005	.34	–

[1] Three months.

[2] Two months.

[3] November omitted.

Housatonic River, below Great Barrington.

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1908, . . .	.18	14.97	3.69	.0106	.0269	.0172	.0097	.43	.0107	.0011	.36	–
1909, . . .	.16	14.91	4.41	.0067	.0247	.0173	.0074	.47	.0078	.0012	.35	–
1910, . . .	.22	14.97	5.32	.0128	.0233	.0181	.0052	.51	.0090	.0021	.34	–
1911, . . .	.19	14.42	5.29	.0178	.0217	.0157	.0060	.45	.0087	.0045	.40	–

Merrimack River.

MERRIMACK RIVER.

Chemical Examination of Water from Merrimack River. — Averages for Six Months, from June to November, inclusive.

Merrimack River, above Lowell.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1887, . . .	.45	4.08	1.10	.0024	.0156	-	-	.17	.0078	-	-	-
1888, . . .	.32	3.47	1.01	.0014	.0161	.0137	.0024	.16	.0082	.0002	-	-
1889, . . .	.37	-	-	.0028	.0166	.0143	.0023	.17	.0067	.0001	-	-
1890, . . .	.34	3.85	1.58	.0025	.0148	.0123	.0025	.14	.0106	.0002	-	1.4
1891, . . .	.27	3.73	1.47	.0029	.0147	.0111	.0036	.17	.0080	.0002	-	1.4
1892, . . .	.39	3.75	1.37	.0028	.0139	.0106	.0033	.15	.0097	.0002	-	1.6
1893, . . .	.25	3.47	1.13	.0028	.0141	.0110	.0031	.17	.0072	.0001	.38	1.1
1894, . . .	.29	3.86	1.32	.0037	.0140	.0114	.0026	.19	.0042	.0001	.36	1.2
1895, . . .	.43	3.97	1.61	.0019	.0197	.0151	.0046	.24	.0054	.0001	.55	1.2
1896, . . .	.44	3.85	1.41	.0049	.0181	.0149	.0032	.18	.0053	.0002	.66	1.0
1897, . . .	.54	3.62	1.68	.0030	.0181	.0148	.0033	.16	.0077	.0001	.52	0.9
1898, . . .	.39	3.93	1.74	.0032	.0197	.0171	.0026	.19	.0047	.0001	.51	1.0
1899, . . .	.20	3.88	1.45	.0050	.0205	.0166	.0039	.22	.0055	.0002	.38	1.2
1900, . . .	.23	3.72	1.21	.0068	.0215	.0158	.0057	.23	.0038	.0002	.44	1.3
1901, . . .	.38	4.32	1.98	.0060	.0208	.0172	.0036	.20	.0042	.0002	.69	1.2
1902, . . .	.38	3.81	1.59	.0056	.0163	.0142	.0021	.17	.0043	.0001	.64	0.9
1903, . . .	.30	4.00	1.55	.0058	.0171	.0129	.0042	.23	.0040	.0002	.59	1.1
1904, . . .	.33	4.61	1.92	.0077	.0194	.0153	.0041	.23	.0047	.0002	.69	1.3
1905, . . .	.40	4.30	1.95	.0112	.0202	.0160	.0042	.25	.0038	.0002	.71	1.1
1906, . . .	.37	4.64	1.84	.0100	.0201	.0174	.0027	.26	.0032	.0002	.71	1.2
1907, . . .	.38	4.60	1.88	.0079	.0194	.0135	.0059	.28	.0043	.0002	.62	1.2
1908, . . .	.29	4.67	1.80	.0125	.0195	.0141	.0054	.36	.0048	.0003	.64	1.3
1909, . . .	.31	5.16	2.38	.0185	.0213	.0161	.0052	.36	.0018	.0002	.68	1.5
1910, . . .	.37	5.11	1.78	.0242	.0221	.0180	.0041	.35	.0035	.0007	.68	1.4
1911, . . .	.39	5.32	2.09	.0166	.0219	.0165	.0054	.36	.0033	.0006	.65	1.5

MERRIMACK RIVER.

CHEMICAL EXAMINATION OF WATER FROM MERRIMAC RIVER, ETC. — *Concluded.*

Merrimack River, above Lawrence.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1887, . . .	.47	4.82	1.24	.0027	.0211	-	-	.22	.0097	-	-	-
1888, . . .	.32	3.64	1.13	.0029	.0197	.0153	.0044	.18	.0074	.0003	-	-
1889, . . .	.35	-	-	.0047	.0212	.0176	.0036	.20	.0053	.0002	-	-
1890, . . .	.37	4.27	1.56	.0061	.0187	.0148	.0039	.19	.0068	.0002	-	1.6
1891, . . .	.21	4.06	1.37	.0066	.0179	.0138	.0041	.21	.0090	.0002	-	1.4
1892, . . .	.46	4.25	1.50	.0054	.0186	.0155	.0031	.19	.0087	.0002	-	1.5
1893, . . .	.40	4.25	1.62	.0084	.0172	.0138	.0034	.23	.0057	.0003	.52	1.3
1894, . . .	.32	3.82	1.35	.0086	.0174	.0142	.0032	.25	.0043	.0001	.40	1.3
1895, . . .	.52	4.45	1.97	.0068	.0251	.0194	.0057	.30	.0067	.0003	.60	1.5
1896, . . .	.46	4.24	1.70	.0100	.0224	.0181	.0043	.25	.0067	.0005	.57	1.3
1897, . . .	.58	4.06	1.67	.0061	.0222	.0190	.0032	.21	.0053	.0002	.53	1.0
1898, . . .	.44	4.46	1.87	.0076	.0262	.0208	.0054	.25	.0050	.0005	.59	1.3
1899, . . .	.24	4.42	1.57	.0138	.0277	.0207	.0070	.32	.0052	.0004	.43	1.3
1900, . . .	.27	4.22	1.35	.0126	.0249	.0190	.0059	.32	.0050	.0003	.46	1.3
1901, . . .	.44	4.73	1.90	.0100	.0280	.0205	.0075	.28	.0070	.0006	.65	1.5
1902, . . .	.42	4.40	1.85	.0110	.0231	.0180	.0051	.26	.0038	.0003	.65	1.1
1903, . . .	.37	4.66	1.73	.0111	.0226	.0166	.0060	.31	.0052	.0005	.64	1.4
1904, . . .	.31	4.67	1.80	.0211	.0247	.0170	.0077	.33	.0053	.0004	.62	1.4
1905, . . .	.44	4.92	2.01	.0177	.0242	.0183	.0059	.38	.0040	.0005	.74	1.2
1906, . . .	.39	5.30	2.12	.0170	.0263	.0215	.0048	.40	.0027	.0005	.72	1.4
1907, . . .	.40	4.92	1.80	.0293	.0253	.0175	.0078	.41	.0047	.0005	.59	1.3
1908, . . .	.33	5.61	2.19	.0354	.0303	.0196	.0107	.57	.0052	.0006	.74	1.5
1909, . . .	.33	6.28	2.04	.0336	.0262	.0196	.0066	.53	.0025	.0007	.67	1.7
1910, . . .	.39	-	-	.0266	0242	.0183	.0059	.53	.0125	.0008	.57	1.6
1911, . . .	.23	8.22	3.10	.0240	.0286	.0227	.0059	.53	.0118	.0007	.65	1.6

MILLER'S RIVER.

A general statement of the condition of this river in the year 1911 will be found on page 30.

MILLER'S RIVER.

CHEMICAL EXAMINATION OF WATER FROM MILLER'S RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Miller's River, below Miller's Falls.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1908,	.54	4.59	2.06	.0054	.0233	.0181	.0052	.34	.0060	.0002	.64	-
1909,	.54	4.38	1.84	.0035	.0207	.0181	.0026	.34	.0030	.0002	.60	-
1910,	.55	5.48	2.28	.0068	.0231	.0202	.0029	.44	.0075	.0002	.68	-
1911,	.66	5.98	2.58	.0056	.0258	.0220	.0038	.35	.0052	.0002	.90	-

NASHUA RIVER.

A general statement of the condition of this river in the year 1911 will be found on page 31.

NASHUA RIVER.

CHEMICAL EXAMINATION OF WATER FROM NASHUA RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

North Branch of Nashua River, below Fitchburg.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1893,	.70	8.32	2.38	.0562	.0405	.0289	.0116	.73	.0097	.0030	.73	2.2
1894,	.66	9.18	2.22	.0987	.0425	.0308	.0117	.99	.0123	.0034	.64	2.4
1895,	.71	9.42	2.72	.1387	.0493	.0381	.0112	1.08	.0088	.0014	.82	2.6
1896,	.57	9.27	2.62	.0898	.0537	.0384	.0153	.95	.0127	.0030	.71	2.4
1897,	.67	7.62	2.50	.0512	.0518	.0389	.0129	.71	.0112	.0009	.79	2.1
1898,	.56	7.02	2.37	.0688	.0629	.0399	.0230	.56	.0097	.0016	.72	1.8
1899,	.53	10.12	2.95	.1507	.0848	.0537	.0311	1.03	.0055	.0013	.83	2.4
1900,	.42	9.55	2.42	.1575	.0825	.0479	.0346	1.03	.0080	.0015	.73	2.6
1901,	.42	8.45	2.58	.0964	.0508	.0347	.0161	.67	.0080	.0013	.69	2.2
1902,	.39	7.83	2.42	.1070	.0557	.0407	.0150	.68	.0072	.0012	.71	1.9
1903,	.38	7.21	2.10	.1200	.0471	.0281	.0190	.73	.0095	.0014	.62	1.7
1904,	.33	9.05	2.70	.1858	.0596	.0341	.0255	.88	.0077	.0015	.70	2.1
1905,	.48	7.66	2.33	.1284	.0568	.0354	.0214	.73	.0053	.0008	.89	2.1
1906,	.47	7.68	2.16	.1037	.0558	.0356	.0202	.75	.0063	.0020	.68	2.0
1907,	.50	10.77	2.72	.2180	.0654	.0350	.0304	1.24	.0065	.0012	.72	2.8
1908,	.52	15.05	3.60	.2605	.0861	.0494	.0367	1.58	.0033	.0016	1.04	-
1909,	.52	15.85	3.42	.3220	.0958	.0563	.0395	1.87	.0027	.0014	1.02	-
1910,	.60	20.11	4.90	.4047	.1235	.0789	.0446	2.29	.0017	.0009	1.03	-
1911,	.51	19.38	5.57	.2848	.1035	.0566	.0469	2.37	.0027	.0015	1.15	-

NASHUA RIVER.

Chemical Examination of Water from Nashua River, etc. — *Concluded.*

North Branch of Nashua River, at Lancaster.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1892, ...	.48	9.75	2.10	.0422	.0274	.0237	.0037	1.11	.0450	.0010	-	3.0
1894, ...	.49	8.07	1.97	.0215	.0226	.0182	.0044	.97	.0295	.0011	.49	2.2
1895, ...	.51	8.28	2.39	.0318	.0272	.0214	.0058	1.01	.0284	.0034	.56	2.3
1896, ...	.57	6.97	2.17	.0253	.0322	.0253	.0069	.66	.0167	.0034	.60	2.0
1897, ...	.65	5.45	2.03	.0225	.0290	.0221	.0069	.40	.0153	.0015	.68	1.5
1898, ...	.48	6.33	2.10	.0409	.0345	.0263	.0082	.56	.0227	.0033	.51	1.7
1899, ...	.39	7.60	2.33	.0739	.0365	.0305	.0060	.75	.0153	.0028	.60	2.0
1900, ...	.29	7.17	1.55	.0545	.0326	.0264	.0062	.81	.0202	.0039	.52	2.1
1901, ...	.37	6.72	2.14	.0432	.0329	.0240	.0089	.54	.0087	.0021	.58	1.9
1902, ...	.40	7.96	2.66	.0757	.0324	.0267	.0057	.70	.0188	.0043	.58	1.8
1903, ...	.36	6.95	2.35	.0473	.0260	.0201	.0059	.58	.0258	.0034	.52	1.6
1904, ...	.32	8.01	2.18	.0803	.0318	.0267	.0051	.80	.0267	.0040	.53	2.0
1905, ...	.34	7.20	2.13	.0616	.0296	.0227	.0069	.70	.0207	.0044	.50	1.9
1906, ...	.44	7.34	2.12	.0519	.0311	.0240	.0071	.72	.0238	.0027	.56	2.0
1907, ...	.44	8.34	2.33	.0600	.0294	.0232	.0062	.89	.0333	.0084	.53	2.1
1908, ...	.40	10.69	2.73	.1075	.0309	.0259	.0050	1.28	.0405	.0090	.58	-
1909, ...	.44	12.26	3.41	.1556	.0330	.0284	.0046	1.46	.0360	.0066	.60	-
1910, ...	.45	13.44	3.82	.1655	.0462	.0366	.0096	1.63	.0388	.0108	.70	-
1911, ...	.51	15.64	4.10	.3067	.0828	.0408	.0420	1.95	.0208	.0083	.92	-

Nashua River, at Pepperell.

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1899, ...	.28	6.91	2.19	.0167	.0248	.0221	.0027	.78	.0137	.0008	.46	2.1
1901, ...	.37	6.00	2.06	.0154	.0266	.0230	.0036	.45	.0092	.0005	.55	1.9
1902, ...	.37	5.81	2.07	.0118	.0184	.0167	.0017	.49	.0162	.0006	.51	1.7
1903, ...	.35	5.15	1.57	.0097	.0180	.0152	.0028	.44	.0128	.0008	.55	1.6
1904,[1]	.30	6.23	1.93	.0111	.0206	.0171	.0035	.58	.0243	.0008	.44	1.9
1908, ...	.32	10.85	3.40	.0317	.0295	.0202	.0093	1.45	.0194	.0008	.63	-
1909, ...	.38	14.29	4.62	.0354	.0376	.0291	.0085	1.95	.0211	.0017	.92	-
1910, ...	.37	14.77	4.14	.0128	.0329	.0252	.0077	1.93	.0207	.0008	.81	-
1911, ...	.40	12.10	3.77	.0423	.0393	.0293	.0100	1.31	.0213	.0048	.62	-

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[1] Three months.

NEPONSET RIVER.

A general statement of the condition of this river in the year 1911 will be found on page 24.

NEPONSET RIVER.

CHEMICAL EXAMINATION OF WATER FROM NEPONSET RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Neponset River, at Hyde Park.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1887, . . .	1.18	8.20	2.22	.0053	.0402	-	-	.98	.0077	-	-	-
1888, . . .	1.12	7.77	2.37	.0040	.0392	.0358	.0034	1.08	.0074	.0003	-	-
1893, . . .	1.27	8.60	2.68	.0233	.0370	.0282	.0088	1.47	.0045	.0009	1.00	2.6
1894, . . .	1.19	12.87	3.03	.0196	.0466	.0333	.0133	2.31	.0033	.0002	1.03	4.1
1895, . . .	.97	10.01	3.07	.0341	.0440	.0373	.0067	1.51	.0042	.0001	1.05	3.7
1896, . . .	1.26	10.41	3.12	.0162	.0431	.0395	.0036	1.68	.0033	.0001	1.26	3.3
1897, . . .	1.30	11.64	3.34	.0336	.0494	.0417	.0077	1.81	.0037	.0001	1.31	4.0
1898, . . .	1.28	8.82	3.52	.0161	.0505	.0398	.0107	1.02	.0023	.0002	1.30	2.7
1899, . . .	1.14	16.24	4.51	.0264	.0936	.0693	.0243	2.20	.0032	.0002	1.76	5.7
1900, . . .	1.10	10.59	2.99	.0400	.0576	.0381	.0195	1.45	.0048	.0005	1.07	3.2
1901, . . .	1.43	13.26	5.09	.0224	.0802	.0591	.0211	1.69	.0036	.0006	1.82	4.2
1902, . . .	1.02	12.57	4.19	.0360	.0640	.0547	.0093	1.72	.0035	.0004	1.29	4.0
1903, . . .	1.29	14.21	4.95	.0278	.0811	.0638	.0173	1.86	.0034	.0010	1.71	4.5
1904, . . .	1.08	16.22	5.68	.0631	.1007	.0777	.0230	2.07	.0037	.0005	1.67	5.6
1905, . . .	1.22	21.88	6.68	.0813	.1043	.0861	.0182	3.44	.0028	.0006	2.22	6.6
1906, . . .	1.35	13.47	4.42	.0549	.0875	.0674	.0201	2.21	.0025	.0008	1.85	3.9
1907, . . .	.90	22.58	6.31	.1201	.1412	.0961	.0451	3.81	.0042	.0004	1.94	6.9
1908, . . .	-	25.40	7.19	.1132	.1209	.0844	.0365	5.08	.0027	.0006	2.01	8.8
1909, . . .	-	28.69	9.08	.1723	.1218	.0898	.0320	5.35	.0027	.0009	2.02	10.0
1910, . . .	-	31.37	10.16	.1740	.1333	.1000	.0333	5.84	.0010	.0002	2.96	10.4
1911, . . .	1.24	18.82	5.49	.0786	.0727	.0539	.0188	3.36	.0025	.0007	1.86	7.1

QUINEBAUG RIVER.

A general statement of the condition of this river in the year 1911 will be found on page 34.

QUINEBAUG RIVER.

CHEMICAL EXAMINATION OF WATER FROM QUINEBAUG RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Quinebaug River, below Southbridge.

[Parts in 100,000.]

YEAR.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1898,	.64	4.18	2.00	.0064	.0372	.0309	.0063	.18	.0050	.0003	.66	0.8
1899,	.44	4.32	1.72	.0071	.0298	.0229	.0069	.23	.0048	.0002	.54	1.2
1900,	.40	4.31	1.56	.0168	.0324	.0211	.0113	.25	.0024	.0003	.52	1.0
1901,	.42	4.52	1.67	.0147	.0232	.0158	.0074	.19	.0050	.0005	.45	1.7
1902,	.36	4.12	1.45	.0068	.0224	.0179	.0045	.24	.0054	.0002	.43	1.2
1903,[1]	.39	3.84	1.37	.0076	.0225	.0181	.0044	.24	.0043	.0002	.52	1.0
1904,	.40	4.17	1.57	.0086	.0247	.0189	.0058	.26	.0068	.0002	.53	1.2
1908,	.46	6.82	2.31	.0075	.0277	.0174	.0103	.33	.0038	.0003	.57	-
1909,	.40	5.48	1.99	.0087	.0275	.0219	.0056	.37	.0077	.0003	.56	-
1910,	.40	6.20	2.27	.0104	.0334	.0246	.0088	.42	.0032	.0004	.53	-
1911,[1]	.50	5.92	2.09	.0180	.0308	.0240	.0068	.41	.0067	.0002	.66	-

[1] Four months.

TAUNTON RIVER.

A general statement of the condition of this river in the year 1911 will be found on page 32.

TAUNTON RIVER.

CHEMICAL EXAMINATION OF WATER FROM TAUNTON RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Taunton River, below Taunton.

[Parts in 100,000.]

YEAR.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1898,	1.56	6.64	3.30	.0109	.0345	.0314	.0031	.61	.0082	.0003	1.51	1.3
1899,	.93	6.31	2.48	.0176	.0317	.0279	.0038	.72	.0060	.0004	1.04	1.2
1900,	.71	6.89	1.91	.0205	.0286	.0258	.0028	1.06	.0112	.0006	.76	1.5
1901,	1.01	6.15	2.45	.0293	.0275	.0255	.0020	.76	.0134	.0005	.92	1.6
1902,[1]	.94	6.92	2.36	.1902	.0363	.0308	.0055	1.29	.0116	.0012	.90	1.4
1903,	.96	7.06	2.60	.0542	.0270	.0234	.0036	1.10	.0177	.0013	1.02	1.7
1904,	.95	6.49	2.60	.0355	.0319	.0264	.0055	.94	.0137	.0008	1.06	1.3
1906,[2]	1.41	7.37	3.11	.0401	.0385	.0331	.0054	.95	.0162	.0008	1.36	1.4
1907,[3]	.94	7.16	2.62	.1031	.0343	.0282	.0061	1.05	.0115	.0009	1.05	1.7
1908,	.73	7.66	2.52	.0469	.0278	.0226	.0052	1.31	.0108	.0011	.74	-
1909,	.90	12.97	3.87	.0416	.0303	.0263	.0040	3.49	.0105	.0014	.88	-
1910,	1.04	19.62	5.69	.0658	.0376	.0305	.0071	6.82	.0110	.0027	.93	-
1911,	1.04	9.65	2.80	.0385	.0330	.0270	.0060	1.73	.0205	.0015	1.04	-

[1] September omitted.

[2] June omitted.

[3] Four months.

TEN MILE RIVER.

A general statement of the condition of this river in the year 1911 will be found on page 33.

TEN MILE RIVER.

CHEMICAL EXAMINATION OF WATER FROM TEN MILE RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Ten Mile River, below Attleborough.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1899,	.71	6.39	2.15	.0072	.0379	.0288	.0091	.62	.0133	.0004	.74	1.7
1900,	.47	6.19	1.60	.0125	.0363	.0241	.0122	.84	.0155	.0004	.49	1.8
1901,	.46	6.09	2.12	.0084	.0290	.0202	.0088	.71	.0222	.0004	.51	1.8
1902,	.41	6.49	1.83	.0073	.0394	.0237	.0157	.88	.0212	.0004	.52	1.9
1903,	.36	7.48	2.39	.0282	.0346	.0200	.0146	.84	.0315	.0020	.53	1.8
1904,	.44	8.89	2.97	.0931	.0527	.0332	.0195	1.03	.0532	.0033	.58	3.5
1906,[1]	.48	17.57	6.45	.1586	.0914	.0490	.0424	1.07	.0638	.0121	.92	7.9
1907,[1]	.42	19.07	6.14	.6036	.1471	.0830	.0641	1.73	.2014	.0100	1.18	7.5
1908,	.40	10.89	3.27	.1108	.0483	.0294	.0189	1.37	.0364	.0035	.61	-
1909,	.47	11.23	2.88	.4322	.0626	.0380	.0246	1.51	.0263	.0086	.78	-
1910,	.29	12.05	3.32	.2422	.0545	.0330	.0215	1.98	.0357	.0051	.48	-
1911,	.76	11.94	3.58	.0604	.0506	.0302	.0204	1.55	.0382	.0036	.94	-

[1] June omitted.

WESTFIELD RIVER.

A general statement of the condition of this river in the year 1911 will be found on page 33.

WESTFIELD RIVER.

CHEMICAL EXAMINATION OF WATER FROM WESTFIELD RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Westfield River, below Westfield.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1902,	.22	4.21	1.60	.0062	.0144	.0118	.0026	.14	.0062	.0002	.39	1.9
1903,	.15	3.68	1.30	.0037	.0127	.0105	.0022	.16	.0088	.0003	.28	1.8
1904,	.21	4.16	1.59	.0067	.0152	.0119	.0033	.16	.0068	.0001	.38	1.9
1906,[1]	.21	4.65	1.48	.0086	.0161	.0135	.0026	.18	.0035	.0003	.29	2.1
1907,	.24	4.49	1.63	.0053	.0137	.0111	.0026	.21	.0075	.0003	.31	2.0
1908,	.17	5.27	2.19	.0218	.0161	.0116	.0045	.27	.0063	.0006	.28	-
1909,	.22	5.56	1.68	.0179	.0187	.0143	.0044	.26	.0075	.0005	.34	-
1910,	.13	6.71	2.39	.0214	.0143	.0120	.0023	.30	.0304	.0010	.21	-
1911,	.25	5.86	2.03	.0272	.0162	.0133	.0029	.28	.0077	.0008	.38	-

[1] Four months.

WATER SUPPLY STATISTICS;

ALSO

RECORDS OF RAINFALL AND FLOW OF STREAMS.

WATER SUPPLY STATISTICS.

During the year 1911 water supplies were introduced into the towns of Ashland (population 1,682), Blackstone (population 5,648), Medway (population 2,696), Russell (population 965), West Bridgewater (population 2,231) and Worthington (population 569). The works in all of these places are owned by the town with the exception of those in Worthington, which are owned by the Worthington Fire District. Water supplies were also introduced into the Deerfield Fire District in the town of Deerfield, the Cherry Valley and Rochdale Water District in the town of Leicester, and South Hadley Fire District No. 2 in the town of South Hadley. The villages of South Deerfield in the town of Deerfield, Leicester in the town of Leicester, and South Hadley Falls in the town of South Hadley had previously been supplied with water.

Of the 354 cities and towns in Massachusetts, all of the 33 cities and 165 of the towns are provided with public water supplies. The following table gives the classification by population of the cities and towns having and not having public water supplies at the end of the year: —

POPULATION, 1910.	Number of Places of Given Population having Public Water Supplies.	Total Population of Places in Preceding Column.	Number of Places of Given Population not having Public Water Supplies.	Total Population of Places in Preceding Column.
Under 500,	-	-	39	13,020
500-999,	6	4,933	41	29,949
1,000-1,499,	17	20,950	33	40,813
1,500-1,999,	12	21,245	21	36,846
2,000-2,499,	20	44,447	13	28,846
2,500-2,999,	11	30,790	3	8,270
3,000-3,499,	8	26,167	1	3,078
3,500-3,999,	5	18,164	2	7,506
Above 4,000,	119	3,018,150	3	13,242
Totals,	198	3,184,846	156	181,570

From the above table it will be seen that although but 56 per cent. of the cities and towns in the State have a public water supply, the total population of the places supplied is 95 per cent. of the total population of the State. The populations given in this table were obtained by using the total population of the cities and towns supplied, and is somewhat greater than the actual number of persons to whom the public water supply is available, but the difference is not great. All of the towns in the State having a population in excess of 5,000 are now supplied with water, and there are only 9 towns having a population in excess of 2,500 which are not provided with public water supplies. These towns are as follows: —

TOWN.	Population, 1910.	TOWN.	Population, 1910.
Barnstable,[1]	4,676	Sutton,	3,078
Dartmouth,	4,378	Westport,	2,928
Warren,	4,188	Somerset,	2,798
Templeton,	3,756	Norton,	2,544
Tewksbury,	3,750		

[1] Works under construction.

At the present time the water works are owned either by the municipality or by a fire or water supply district in all of the cities and 124 of the towns, while in 41 towns the works are owned by private companies. The following table gives the classification by population of the cities and towns which own their water works and those which are supplied with water by water companies: —

POPULATION, 1910.	Number of Places of Given Population owning Water Works.	Total Population of Places in Preceding Column.	Number of Places of Given Population supplied with Water by Private Companies.	Total Population of Places in Preceding Column.
Under 1,000,	3	2,251	3	2,682
1,000-1,999,	20	28,964	9	13,231
2,000-2,999,	21	50,137	10	25,100
3,000-3,999,	6	20,348	7	23,983
4,000-4,999,	12	55,128	3	13,811
5,000-5,999,	16	87,513	3	15,939
6,000-6,999,	8	52,608	-	-
7,000-7,999,	5	36,945	1	7,688
Above 8,000,	66	2,696,170	5	52,348
Totals,	157	3,030,064	41	154,782

From the above table it will be seen that the total population of all places supplied by private companies is only 4.9 per cent. of the total population of all of the cities and towns supplied with water, and there are only 9 towns having a population in excess of 5,000 which are supplied by private companies, namely, Milford, Southbridge, Dedham, Northbridge, Palmer, Bridgewater, Grafton, Fairhaven and Amherst.

CONSUMPTION OF WATER.

Records of the consumption of water are kept in nearly all of the cities and towns where water is pumped, and in several places supplied by gravity Venturi meters are used to measure the quantity supplied.

The following table gives statistics with regard to the consumption of water in the year 1911 in those cities and towns from which records could be obtained. The populations for the year 1911 as given in the table were obtained by adding one-fifth of the increase in population between 1905 and 1910 to the population as determined by the census of the latter year. The daily consumption of water per inhabitant has been obtained by dividing the average daily consumption by the estimated total population of the city or town in 1911. The quantity obtained in this manner is somewhat less than the actual consumption per person using the water because there are in all cities and towns a greater or less number of persons who do not use the public supply. The difference between the number of inhabitants and the number of consumers would account to a large extent for the low rate per inhabitant in some of the towns which contain villages to which the public water supply has not been extended and in towns where the works have been in operation but a short time and where, in consequence, water has not come into general use. In some towns the population during the summer months is much greater than that shown by the census returns, and in such cases the consumption per inhabitant as given in the table is higher than it would be if allowance were made for the increased population in the summer. With a few exceptions, however, the difference is not great.

Statistics relating to the Consumption of Water in Various Cities and Towns.

CITY OR TOWN.	Estimated Population, 1911.	Average Daily Consumption (Gallons), 1911.	Daily Consumption per Inhabitant (Gallons), 1911.	CITY OR TOWN.	Estimated Population, 1911.	Average Daily Consumption (Gallons), 1911.	Daily Consumption per Inhabitant (Gallons), 1911.
Metropolitan Water District:[1] —	1,097,174	113,490,000	103	Chelmsford,	5,161	74,000	14
Arlington,	11,491	983,000	86	Clinton,	13,069	603,000	46
Belmont,	5,778	416,000	72	Cohasset,	2,557	291,000	114
Boston,	685,626	85,572,000	125	Concord,	6,621	493,000	74
Chelsea,	34,639	2,701,000	78	Danvers and Middleton,	10,617	926,000	87
Everett,	34,359	2,558,000	74	Dedham,	9,586	1,235,000	129
Lexington,	4,996	353,000	71	Dudley,	4,357	88,000	20
Malden,	45,677	1,971,000	43	Easton,	5,185	130,000	25
Medford,	23,843	1,207,000	51	Edgartown,	1,194	54,000	45
Melrose,	15,999	1,013,000	63	Fairhaven,	5,299	427,000	81
Milton,	8,098	318,000	39	Fall River,	122,002	5,177,000	42
Nahant,	1,236	152,000	123	Falmouth,	3,125	365,000	117
Quincy,	33,555	2,925,000	87	Foxborough,	3,963	200,000	50
Revere,	19,331	1,439,000	74	Framingham,	13,228	723,000	55
Somerville,	78,829	5,899,000	75	Gardner,	15,236	658,000	43
Stoneham,	7,242	573,000	79	Gloucester,	24,075	1,300,000	54
Swampscott,	6,417	428,000	67	Grafton,	5,836	88,000	15
Watertown,	13,198	889,000	67	Groton,	2,135	79,000	37
Winthrop,	10,752	598,000	56	Holliston,	2,721	67,000	25
Abington and Rockland.	12,586	646,000	51	Holyoke,	59,289	5,591,000	94
Amesbury,	10,105	471,000	47	Hudson,	6,848	261,000	38
Andover,	7,435	557,000	75	Hyde Park,	15,706	912,000	58
Attleborough,	16,918	872,000	52	Ipswich,	5,891	256,000	43
Avon,	2,035	69,000	34	Lancaster,	2,476	107,000	43
Ayer,	2,879	142,000	49	Lawrence,	89,060	3,943,000	44
Bedford,	1,236	24,000	19	Lincoln,	1,186	196,000	165
Beverly,	19,335	1,602,000	83	Longmeadow,	1,108	93,000	84
Billerica,	2,778	123,000	44	Lowell,	108,575	5,273,000	49
Braintree,	8,303	524,000	63	Lynn and Saugus,	100,201	6,710,000	67
Bridgewater and East Bridgewater.	11,277	266,000	24	Manchester,	2,684	330,000	123
Brockton,	58,695	2,490,000	42	Mansfield,	5,371	508,000	95
Brookline,	28,663	2,605,000	91	Marblehead,	7,364	550,000	75
Cambridge,	106,320	10,226,000	96	Marion,	1,546	92,000	60
Canton,	4,816	323,000	67	Marlborough,	14,680	529,000	36

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[1] Including Newton and Hyde Park, which are within the district, but supplied from independent works.

Statistics relating to the Consumption of Water in Various Cities and Towns — Concluded.

City or Town.	Estimated Population, 1911.	Average Daily Consumption (Gallons), 1911.	Daily Consumption per Inhabitant (Gallons), 1911.	City or Town.	Estimated Population, 1911.	Average Daily Consumption (Gallons), 1911.	Daily Consumption per Inhabitant (Gallons), 1911.
Maynard, . .	6,506	280,000	43	Randolph and Holbrook.	7,232	475,000	66
Merrimac, . .	2,266	90,000	40	Reading, . .	5,845	221,000	38
Methuen, . .	12,002	489,000	41	Rockport, . .	4,164	267,000	64
Middleborough, .	8,479	372,000	44	Rutland, . .	1,749	96,000	55
Milford and Hopedale.	15,461	720,000	47	Salem, . . .	44,911	3,298,000	73
Millbury, . .	4,762	216,000	45	Sharon, . . .	2,355	142,000	60
Montague and Erving.	7,995	596,000	75	Shirley, . . .	2,228	50,000	22
Nantucket, . .	2,968	229,000	77	Southbridge, . .	12,910	1,054,000	82
Natick, . . .	9,917	536,000	54	Stoughton, . .	6,387	247,000	39
Needham, . .	5,174	308,000	60	Taunton, . .	34,917	2,233,000	64
New Bedford, .	101,110	7,974,000	79	Wakefield, . .	11,631	664, 000	57
Newburyport, .	15,004	1,186,000	79	Walpole, . .	5,070	514,000	101
Newton, . .	40,402	2,583,000	64	Waltham, . .	28,144	2,513,000	89
North Andover, .	5,712	271,000	47	Ware, . . .	8,810	405,000	46
North Attleborough,	9,899	484,000	49	Wareham, . .	4,190	149,000	36
North Brookfield, .	3,167	224,000	71	Webster, . .	11,807	458,000	39
Norwood, . .	8,271	562,000	68	Wellesley, . .	5,258	354,000	67
Oak Bluffs, . .	1,073	195,000	182	Westford, . .	2,939	62,000	21
Orange, . . .	5,223	145,000	28	Weston, . . .	2,109	107,000	51
Peabody, . .	16,246	2,473,000	152	Whitman, . .	7,446	230,000	31
Pepperell, . .	2,890	135,000	47	Winchendon, . .	5,627	205,000	36
Plainville, . .	1,402	36,000	26	Woburn, . .	15,489	1,856,000	120
Plymouth, . .	12,345	1,310,000	106	Worcester, . .	149,556	10,280,000	69
Provincetown, .	4,370	178,000	41	Wrentham, . .	1,806	55,000	30

RAINFALL.

The normal rainfall in Massachusetts as deduced from long-continued observations in various parts of the State is 44.86 inches. The average rainfall for the year 1911 in these places was 40.24 inches, an average deficiency of 4.62 inches. There was an excess of precipitation in July, August, October and November, but in the other eight months of the year there was a deficiency. The greatest excess in any one month occurred in August when the rainfall was 5.43 inches, or 1.17 inches greater than the normal, and the greatest deficiency occurred in May when the rainfall was 1.04 inches, or 2.66 inches less than the normal.

The following table gives the normal rainfall in the State for each month as deduced from observations at various places for a long period of years, together with the average rainfall at those places for each month during the year 1911 and the departure from the normal.

MONTH.	Normal Rainfall (Inches).	Rainfall in 1911 (Inches).	Excess or Deficiency in 1911 (Inches).	MONTH.	Normal. Rainfall (Inches).	Rainfall in 1911 (Inches).	Excess or Deficiency in 1911 (Inches).
January, . .	3.76	2.76	—1.00	August, . .	4.26	5.43	+1.17
February, .	3.62	2.50	—1.12	September, .	3.52	3.17	—0.35
March, . .	3.90	3.30	—0.60	October, . .	3.86	4.75	+0.89
April, . .	3.57	2.48	—1.09	November, .	3.92	4.54	+0.62
May, . .	3.70	1.04	—2.66	December, .	3.65	3.47	—0.18
June, . .	3.32	2.71	—0.61				
July, . .	3.78	4.09	+0.31	Total, .	44.86	40.24	—4.62

In the year 1911, as in each of the seven years immediately preceding it, there was a deficiency in rainfall, the greatest deficiencies occurring in the years 1908 and 1910 and the least in the years 1906 and 1907. The deficiency in the year 1911, however, unlike that in any of the preceding years, occurred almost entirely in the first six months, during which period the total rainfall amounted to only 14.79 inches, which is 7.08 inches, or one-third, less than the total normal rainfall for that period. The total rainfall in the last six months was 63 per cent. and in the last three months 32 per cent. of the total rainfall for the year.

As a result of the marked deficiency in the rainfall in the winter and spring months, when the flow of streams is usually high and the ponds and storage reservoirs are ordinarily refilled, many ponds and reservoirs — particularly those with comparatively small watersheds — failed to fill, thus causing a very decided shortage of water in several cities and towns. The greatly increased rainfall, which began in the latter part of July and continued throughout the remainder of the year, retarded the further lowering of the water level in the reservoirs, but it was not until the latter part of the year that the effect of this increased rainfall was noticed in the gradual raising of the water level in the ponds and reservoirs, and in spite of the greater rainfall in that year the conditions at the end of 1911 did not vary materially from those existing at the close of the preceding year. As in some of the preceding years the regular sources of water supply in several places were exhausted or reduced to such low levels that it was necessary to supplement the supply with water taken from the nearest available stream or reservoir, and in other places the introduction of a supplementary supply was only avoided by greatly restricting the use of water from the public works.

FLOW OF STREAMS.

Sudbury River.

The average flow of the Sudbury River during the year 1911 was 514,000 gallons per day per square mile, or 51 per cent. of the normal flow for the past thirty-seven years. In that period there has been no other year in which the average flow has been less, the year next approaching it in low flow being 1883, when the average flow was 533,000 gallons per day per square mile, or 53 per cent. of the normal flow. In 1911 the flow during every month was less than the normal, the greatest deficiency occurring in the months of February and March. During the month of July the flow was less than the evaporation from the water surfaces of the reservoirs, so that the flow is represented by a minus quantity. The average flow for the driest six months, May to October, inclusive, was 152,000 gallons per day per square mile, or 38 per cent. of the normal flow for such period during the past thirty-seven years.

In order to show the relation between the flow of the Sudbury River during each month of the year 1911 and the normal flow of that stream, as deduced from observations during thirty-seven years, from 1875 to 1911, inclusive, the following table has been prepared. The area of the watershed of the Sudbury River above the point of measurement is 75.2 square miles.

Table showing the Average Monthly Flow of the Sudbury River for the Year 1911, in Cubic Feet per Second per Square Mile of Drainage Area, and in Million Gallons per Day per square Mile of Drainage Area; also, Departure from the Normal Flow.

MONTH.	NORMAL FLOW.		ACTUAL FLOW IN 1911.		EXCESS OR DEFICIENCY.	
	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.
January,	1.870	1.209	0.803	0.519	—1.067	—0.690
February,	2.686	1.735	1.084	0.700	—1.602	—1.035
March,	4.318	2.790	1.771	1.144	—2.547	—1.646
April,	3.078	1.989	2.206	1.426	—0.872	—0.563
May,	1.636	1.058	0.492	0.318	—1.144	—0.740
June,	0.784	0.507	0.329	0.213	—0.455	—0.294
July,	0.256	0.166	—0.022	—0.014	—0.278	—0.180
August,	0.373	0.241	0.032	0.020	—0.341	—0.221
September,	0.380	0.246	0.117	0.076	—0.263	—0.170
October,	0.695	0.449	0.458	0.296	—0.237	—0.153
November,	1.244	0.804	0.918	0.593	—0.326	—0.211
December,	1.571	1.016	1.405	0.908	—0.166	—0.108
Average for whole year,	1.568	1.013	0.796	0.514	—0.772	—0.499

The following table gives the rainfall upon the Sudbury River watershed and the total yield expressed in inches in depth upon the watershed (inches of rainfall collected) for each of the past thirty-seven years, from 1875 to 1911, inclusive, together with the average for the entire period: —

Rainfall, in Inches, received and collected on the Sudbury River Watershed.

MONTH.	1875.			1876.			1877.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	2.42	0.184	7.6	1.83	1.147	62.7	3.22	1.174	36.5
February,	3.15	2.411	76.5	4.21	2.282	54.2	0.74	1.529	206.9
March,	3.74	2.862	76.5	7.43	7.911	106.5	8.36	8.586	102.7
April,	3.23	5.263	162.9	4.20	5.683	135.4	3.48	4.182	120.3
May,	3.56	2.119	59.5	2.76	2.031	73.5	3.70	2.482	67.0
June,	6.24	1.501	24.0	2.04	0.383	18.8	2.43	1.031	42.5
July,	3.57	0.573	16.0	9.13	0.326	3.6	2.95	0.360	12.2
August,	5.53	0.706	12.8	1.72	0.723	42.0	3.68	0.216	5.9
September,	3.43	0.358	10.4	4.62	0.318	6.9	0.32	0.103	31.9
October,	4.85	1.152	23.8	2.24	0.417	18.6	8.52	1.127	13.2
November,	4.83	2.248	46.5	5.76	1.878	32.6	5.80	2.447	42.2
December,	0.94	1.041	110.7	3.62	0.809	22.3	0.87	2.300	264.4
Totals and averages,	45.49	20.418	44.9	49.56	23.908	48.2	44.02	25.487	57.9

MONTH.	1878.			1879.			1880.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	5.63	3.228	57.3	2.48	1.249	50.4	3.57	2.000	56.0
February,	5.97	3.972	66.5	3.56	2.756	77.4	3.98	2.982	74.9
March,	4.69	6.256	133.4	5.14	4.156	80.9	3.31	2.451	73.9
April,	5.79	2.807	48.5	4.72	5.379	114.1	3.11	2.017	65.0
May,	0.96	2.487	260.2	1.58	1.987	125.8	1.84	0.917	50.0
June,	3.88	0.873	22.5	3.79	0.713	18.8	2.14	0.303	14.2
July,	2.97	0.229	7.7	3.93	0.281	7.1	6.27	0.315	5.0
August,	6.94	0.848	12.2	6.51	0.705	10.8	4.01	0.212	5.3
September,	1.29	0.277	21.5	1.88	0.243	12.9	1.60	0.138	8.6
October,	6.42	0.921	14.3	0.81	0.126	15.6	3.74	0.181	4.8
November,	7.02	2.922	41.6	2.68	0.355	13.2	1.78	0.354	19.9
December,	6.37	5.667	89.0	4.34	0.825	19.0	2.83	0.312	11.0
Totals and averages,	57.93	30.487	52.6	41.42	18.775	45.3	38.18	12.182	31.9

Rainfall, in Inches, received and collected, etc. — Continued.

MONTH.	1881.			1882.			1883.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	5.56	0.740	13.3	5.95	2.213	37.2	2.81	0.597	21.2
February,	4.65	2.491	53.6	4.55	3.872	85.2	3.87	1.664	43.0
March,	5.73	7.142	124.6	2.65	5.064	191.2	1.78	2.873	161.4
April,	2.00	2.669	133.4	1.82	1.497	82.1	1.84	2.330	126.3
May,	3.51	1.721	49.0	5.07	2.304	45.5	4.19	1.673	40.0
June,	5.39	2.309	42.8	1.66	0.913	54.9	2.40	0.518	21.6
July,	2.35	0.493	21.0	1.77	0.154	8.7	2.68	0.206	7.7
August,	1.36	0.264	19.4	1.67	0.099	5.9	0.73	0.140	19.1
September,	2.62	0.340	13.0	8.74	0.529	6.0	1.52	0.157	10.4
October,	2.95	0.331	11.2	2.07	0.534	25.7	5.60	0.331	5.9
November,	4.09	0.682	16.7	1.15	0.362	31.5	1.81	0.354	19.5
December,	3.96	1.383	34.9	2.30	0.561	24.5	3.55	0.345	9.7
Totals and averages,	44.17	20.565	46.6	39.40	18.102	45.9	32.78	11.188	34.1

MONTH.	1884.			1885.			1886.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	5.09	1.775	34.9	4.71	2.203	46.8	6.36	2.606	40.9
February,	6.54	4.742	72.5	3.87	2.182	56.4	6.28	7.734	123.2
March,	4.72	6.752	143.1	1.07	2.805	262.1	3.61	3.672	101.7
April,	4.41	4.925	111.8	3.60	3.133	86.9	2.22	3.361	151.1
May,	3.47	1.838	53.0	3.48	2.383	68.4	3.00	1.285	42.9
June,	3.44	0.719	20.9	2.87	0.735	25.7	1.47	0.350	23.9
July,	3.67	0.399	10.9	1.43	0.111	7.8	3.27	0.206	6.3
August,	4.65	0.458	9.8	7.18	0.429	6.0	4.10	0.168	4.1
September,	0.85	0.076	8.9	1.43	0.209	14.7	2.90	0.203	7.0
October,	2.48	0.148	6.0	5.09	0.599	11.8	3.24	0.260	8.0
November,	2.65	0.302	11.4	6.09	2.033	33.3	4.64	1.161	25.0
December,	5.17	1.650	31.9	2.72	2.094	77.0	4.97	1.819	36.6
Totals and averages,	47.14	23.784	50.5	43.54	18.916	43.4	46.06	22.825	49.5

Rainfall, in Inches, received and collected, etc. — Continued.

MONTH.	1887.			1888.			1889.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	5.20	4.619	88.8	4.15	1.878	45.3	5.37	4.963	92.4
February,	4.78	4.558	95.3	3.68	3.255	88.3	1.65	1.926	116.4
March,	4.90	5.116	104.4	6.02	5.775	95.9	2.37	2.388	100.9
April,	4.27	4.522	106.0	2.43	4.566	188.3	3.41	2.434	71.4
May,	1.16	1.799	154.5	4.82	2.912	60.3	2.95	1.569	53.3
June,	2.65	0.714	26.9	2.54	0.728	28.7	2.80	1.128	40.3
July,	3.76	0.204	5.5	1.41	0.209	14.9	8.94	1.130	12.6
August,	5.28	0.382	7.2	6.22	0.677	10.9	4.18	2.554	61.2
September,	1.32	0.191	14.5	8.59	1.994	23.2	4.60	1.422	30.9
October,	2.83	0.339	12.0	4.99	3.566	71.4	4.25	2.194	51.6
November,	2.67	0.636	23.8	7.22	4.761	65.9	6.29	3.351	53.3
December,	3.88	1.147	29.6	5.40	5.428	100.6	3.14	3.997	127.3
Totals and averages,	42.70	24.227	56.7	57.47	35.749	62.2	49.95	29.056	58.2

MONTH.	1890.			1891.			1892.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	2.53	2.237	88.4	7.02	5.383	76.7	5.85	3.335	57.0
February,	3.51	2.463	70.3	5.23	5.616	107.3	3.14	1.574	50.1
March,	7.73	6.498	84.0	6.48	7.944	122.7	4.06	3.488	85.9
April,	2.64	3.236	122.3	3.91	4.138	106.0	0.83	1.504	181.1
May,	5.21	2.437	46.8	2.01	1.039	51.7	5.58	2.245	40.2
June,	2.03	0.980	48.3	3.77	0.714	18.9	2.76	0.739	26.8
July,	2.46	0.191	7.8	3.39	0.266	7.8	4.23	0.382	9.0
August,	3.87	0.235	6.1	4.73	0.290	6.1	4.44	0.500	11.3
September,	6.00	0.790	13.2	2.38	0.350	14.7	2.84	0.396	13.9
October,	10.51	4.053	38.6	3.83	0.375	9.8	1.17	0.224	19.2
November,	1.20	2.097	174.7	3.09	0.526	17.0	5.80	1.204	20.7
December,	5.31	1.776	33.5	3.68	0.971	26.3	1.13	0.865	76.9
Totals and averages,	53.00	26.993	50.9	49.52	27.612	55.8	41.83	16.456	39.3

Rainfall, in Inches, received and collected, etc. — Continued.

MONTH.	1893.			1894.			1895.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January, ...	2.92	0.773	26.4	4.09	1.236	30.2	4.06	1.844	45.4
February, ...	8.20	2.485	30.3	3.91	1.596	40.8	1.39	0.871	62.5
March, ...	3.67	5.789	157.7	1.43	3.992	278.2	2.98	4.299	144.2
April, ...	3.60	3.668	101.7	3.42	2.832	82.9	5.25	4.341	82.7
May, ...	6.61	5.143	77.8	4.24	1.498	35.4	2.02	1.134	56.1
June, ...	2.38	0.759	31.9	1.15	0.723	62.6	2.77	0.301	10.8
July, ...	2.57	0.282	11.0	3.26	0.287	8.8	5.04	0.411	8.2
August, ...	5.41	0.322	5.9	2.03	0.373	18.4	4.15	0.409	9.9
September, ...	1.74	0.187	10.8	2.63	0.258	9.8	2.30	0.153	6.7
October, ...	4.07	0.395	9.7	5.34	0.668	12.5	10.68	2.460	23.0
November, ...	2.20	0.550	25.1	3.43	1.442	42.1	6.63	4.794	72.4
December, ...	4.86	1.421	29.2	4.81	1.277	26.5	3.35	3.179	94.9
Totals and averages, .	48.23	21.774	45.2	39.74	16.182	40.7	50.62	24.196	47.8

MONTH.	1896.			1897.			1898.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January, ...	2.39	1.933	80.9	4.00	1.507	37.6	6.83	2.922	42.8
February, ...	7.18	4.466	62.2	2.91	1.718	59.0	4.49	4.869	108.5
March, ...	5.24	6.841	130.7	3.66	4.575	125.0	2.40	4.645	193.5
April, ...	1.57	2.579	164.3	2.82	2.615	92.7	4.66	3.158	67.8
May, ...	2.57	0.641	24.9	4.37	1.632	37.3	3.22	2.222	68.9
June, ...	3.22	0.689	21.4	4.46	1.661	37.3	2.48	0.915	36.9
July, ...	2.51	0.170	6.8	5.44	1.174	21.6	4.09	0.411	10.1
August, ...	2.40	0.102	4.3	3.51	1.053	30.0	8.17	1.974	24.2
September, ...	7.72	0.669	8.7	2.94	0.315	10.7	2.62	0.637	24.4
October, ...	3.76	1.055	28.0	0.47	0.168	35.7	6.71	2.069	30.8
November, ...	3.02	1.137	37.7	6.40	1.570	24.5	6.93	3.429	49.5
December, ...	2.12	1.171	55.1	5.21	2.827	54.3	3.28	3.208	97.7
Totals and averages, .	43.70	21.453	49.1	46.19	20.815	45.1	55.88	30.459	54.5

Rainfall, in Inches, received and collected, etc. — Continued.

MONTH.	1899.			1900.			1901.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January, ...	4.18	4.082	97.7	4.96	1.417	28.6	1.82	0.779	42.7
February, . . .	4.91	2.225	45.3	9.14	6.123	67.0	1.52	0.483	31.7
March, ...	7.01	7.501	107.0	6.35	6.518	102.6	6.57	4.912	74.8
April, ...	1.90	4.351	229.0	2.58	2.330	90.2	8.60	7.257	84.4
May, ...	1.45	0.911	62.8	4.32	2.341	54.2	7.23	5.269	72.9
June, ...	2.51	0.114	4.6	2.99	0.545	18.3	1.38	1.299	94.1
July, ...	3.22	0.035	1.1	2.42	—0.032	—1.3	5.71	0.545	9.6
August, ...	1.43	—0.063	—4.4	2.26	—0.060	—2.7	4.57	0.756	16.5
September, . . .	3.95	0.162	4.1	3.36	0.112	3.3	3.30	0.527	15.9
October, ...	2.69	0.206	7.7	3.83	0.331	8.6	2.82	0.734	26.0
November, . . .	2.18	0.525	24.1	5.70	1.144	20.1	2.90	0.819	28.3
December, . . .	1.78	0.392	22.0	2.74	1.955	71.4	9.69	4.808	49.6
Totals and averages, .	37.21	20.441	54.9	50.65	22.724	44.9	56.11	28.188	50.2

MONTH.	1902.			1903.			1904.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January, ...	2.52	3.145	125.1	3.80	3.096	81.4	4.87	0.851	17.5
February, . . .	6.18	2.697	43.6	3.95	3.672	93.0	3.00	1.472	49.1
March, ...	5.34	7.491	140.3	6.63	6.161	92.9	2.72	5.349	196.8
April, ...	4.13	3.254	78.8	2.99	3.903	130.5	8.87	5.685	64.1
May, ...	1.86	1.325	71.3	0.93	0.625	67.4	2.65	3.112	117.7
June, ...	2.89	0.523	18.1	9.25	3.431	37.1	2.80	0.723	25.8
July, ...	2.94	0.117	4.0	2.77	0.794	28.7	1.96	0.111	5.7
August, ...	3.40	0.240	7.1	3.67	0.547	14.9	3.86	0.303	7.8
September, . . .	4.54	0.308	6.8	1.75	0.225	12.8	5.80	0.685	11.8
October, ...	4.44	0.902	20.3	4.72	0.877	18.6	1.64	0.348	21.2
November, . . .	1.45	0.767	52.7	1.56	0.626	40.2	1.73	0.499	28.8
December, . . .	6.38	3.173	49.8	3.14	1.038	33.1	2.92	0.481	16.5
Totals and averages, .	46.07	23.942	52.0	45.16	24.995	55.3	42.82	19.619	45.8

Rainfall, in Inches, received and collected, etc. — Continued.

Month.	1905.			1906.			1907.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January, ...	5.26	2.516	47.8	2.47	2.012	81.5	3.28	2.411	73.4
February, . . .	2.20	0.531	24.2	2.92	1.676	57.4	2.17	1.005	46.2
March, ...	3.15	4.456	141.6	6.32	4.297	68.0	1.91	2.958	154.6
April, ...	2.72	2.837	140.2	2.88	3.364	116.6	3.41	2.774	81.5
May, ...	1.31	0.530	40.3	5.66	1.890	33.4	3.63	1.584	43.6
June, ...	5.00	0.806	16.1	3.91	1.220	31.2	3.53	1.314	37.2
July, ...	5.47	0.316	5.8	3.42	0.709	20.7	1.86	0.015	0.8
August, ...	2.70	0.204	7.6	3.02	0.321	10.6	1.07	—0.186	—17.4
September, . . .	6.88	2.152	31.3	3.30	0.034	1.0	8.76	0.934	10.7
October, ...	1.54	0.282	18.3	3.40	0.538	15.8	4.17	1.321	31.7
November, . . .	2.07	0.481	23.3	2.69	0.834	31.1	6.12	3.450	56.4
December, . . .	4.01	1.583	39.5	4.49	1.175	26.2	4.47	3.624	81.1
Totals and averages, .	42.31	16.694	39.5	44.48	18.070	40.6	44.38	21.204	47.8

Month.	1908.			1909.			1910.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January, ...	3.60	3.434	95.4	3.98	0.700	17.6	5.39	2.657	49.2
February, . . .	4.56	2.564	56.3	5.80	3.684	63.6	5.06	2.979	58.9
March, ...	3.82	4.026	105.5	4.26	3.093	72.7	0.85	3.486	408.7
April, ...	1.88	1.929	102.6	4.67	2.970	63.6	2.75	1.151	41.9
May, ...	5.51	1.865	33.9	2.42	1.791	73.9	1.29	0.495	38.4
June, ...	0.86	0.335	38.9	2.81	0.413	1.5	4.68	0.891	19.0
July, ...	3.71	—0.025	—0.7	1.59	—0.216	—1.4	2.03	—0.182	—9.0
August, ...	4.57	0.181	4.0	2.93	—0.080	—2.7	2.62	—0.130	—5.0
September, . . .	0.97	—0.141	—14.5	4.74	0.257	5.4	2.49	0.008	0.3
October, ...	2.55	0.083	3.3	1.12	—0.091	—8.1	1.86	—0.091	—4.9
November, . . .	0.98	0.122	12.5	3.38	0.142	4.2	4.13	0.304	7.4
December, . . .	3.14	0.243	7.7	4.05	0.469	11.6	2.49	0.395	15 8
Totals and averages, .	36.15	14.616	40.4	41.75	13.132	31.5	35.64	11.963	33.6

Rainfall, in Inches, received and collected, etc. — Concluded.

MONTH.	1911.			MEAN FOR THIRTY-SEVEN YEARS, 1875-1911.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	2.88	0.925	32.1	4.14	2.156	52.1
February,	2.77	1.128	40.7	4.21	2.818	67.0
March,	3.59	2.042	56.9	4.37	4.978	113.9
April,	2.81	2.461	87.4	3.50	3.434	98.2
May,	1.01	0.567	56.1	3.27	1.887	57.6
June,	2.53	0.367	14.6	3.13	0.875	27.9
July,	3.19	—0.025	—0.8	3.55	0.295	8.3
August,	4.94	0.036	0.7	3.88	0.430	11.1
September,	2.75	0.131	4.8	3.50	0.424	12.1
October,	3.69	0.528	14.3	3.92	0.801	20.4
November,	4.62	1.024	22.2	3.86	1.387	36.0
December,	3.60	1.620	44.9	3.80	1.812	47.6
Totals and averages,	38.38	10.804	28.2	45.13	21.297	47.2

The following table gives a record of the yield of the Sudbury River watershed for each of the past thirty-seven years, the flow being expressed in gallons per day per square mile of watershed in order to render the table more convenient for use in estimating the probable yield of watersheds used as sources of water supply: —

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile.[1]

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.
January,	103,000	643,000	658,000	1,810,000	700,000	1,121,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000
March,	1,604,000	4,435,000	4,813,000	3,507,000	2,330,000	1,374,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,168,000
May,	1,188,000	1,139,000	1,391,000	1,394,000	1,114,000	514,000
June,	870,000	222,000	597,000	506,000	413,000	176,000
July,	321,000	183,000	202,000	128,000	158,000	177,000
August,	396,000	405,000	121,000	475,000	395,000	119,000
September,	207,000	184,000	60,000	160,000	141,000	80,000
October,	646,000	234,000	632,000	516,000	71,000	101,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000
December,	584,000	454,000	1,289,000	3,177,000	462,000	175,000
Average for whole year,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000
Average for driest six months,	574,000	384,000	502,000	532,000	230,000	143,000

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[1] The area of the Sudbury River watershed used in making up these records included water surfaces amounting to about 2 per cent. of the whole area, from 1875 to 1878 inclusive, subsequently increasing by the construction of storage reservoirs to about 3 per cent. in 1879, to 3.5 per cent. in 1885, to 4 per cent. in 1894 and to 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Continued.

MONTH.	1881.	1882.	1883.	1884.	1885.	1886.
January,	415,000	1,241,000	335,000	995,000	1,235,000	1,461,000
February,	1,546,000	2,403,000	1,033,000	2,842,000	1,354,000	4,800,000
March,	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000	2,059,000
April,	1,546,000	867,000	1,350,000	2,853,000	1,815,000	1,947,000
May,	965,000	1,292,000	938,000	1,030,000	1,336,000	720,000
June,	1,338,000	529,000	300,000	417,000	426,000	203,000
July,	276,000	86,000	115,000	224,000	62,000	115,000
August,	148,000	55,000	78,000	257,000	240,000	94,000
September,	197,000	306,000	91,000	44,000	121,000	118,000
October,	186,000	299,000	186,000	83,000	336,000	146,000
November,	395,000	210,000	205,000	175,000	1,178,000	673,000
December,	775,000	314,000	193,000	925,000	1,174,000	1,020,000
Average for whole year,	979,000	862,000	533,000	1,129,000	901,000	1,087,000
Average for driest six months,	330,000	211,000	145,000	200,000	391,000	223,000

MONTH.	1887.	1888.	1889.	1890.	1891.	1892.
January,	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000
February,	2,829,000	1,951,000	1,195,000	1,529,000	3,486,000	943,000
March,	2,868,000	3,237,000	1,339,000	3,643,000	4,453,000	1,955,000
April,	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000
May,	1,009,000	1,632,000	880,000	1,366,000	582,000	1,259,000
June,	414,000	422,000	653,000	568,000	414,000	428,000
July,	114,000	117,000	633,000	108,000	149,000	214,000
August,	214,000	380,000	1,432,000	132,000	163,000	280,000
September,	111,000	1,155,000	824,000	458,000	203,000	229,000
October,	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000
November,	368,000	2,758,000	1,941,000	1,215,000	305,000	697,000
December,	643,000	3,043,000	2,241,000	997,000	544,000	485,000
Average for whole year,	1,154,000	1,697,000	1,383,000	1,285,000	1,315,000	781,000
Average for driest six months,	234,000	953,000	944,000	747,000	239,000	327,000

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Continued.

MONTH.	1893.	1894.	1895.	1896.	1897.	1898.
January,	433,000	693,000	1,034,000	1,084,000	845,000	1,638,000
February,	1,542,000	991,000	541,000	2,676,000	1,067,000	3,022,000
March,	3,245,000	2,238,000	2,410,000	3,835,000	2,565,000	2,604,000
April,	2,125,000	1,640,000	2,515,000	1,494,000	1,515,000	1,829,000
May,	2,883,000	840,000	636,000	360,000	915,000	1,246,000
June,	440,000	419,000	174,000	399,000	962,000	530,000
July,	158,000	161,000	231,000	95,000	658,000	231,000
August,	181,000	209,000	229,000	57,000	591,000	1,107,000
September,	108,000	150,000	89,000	388,000	182,000	369,000
October,	221,000	374,000	1,379,000	592,000	94,000	1,160,000
November,	319,000	836,000	2,777,000	659,000	909,000	1,986,000
December,	797,000	716,000	1,782,000	657,000	1,584,000	1,799,000
Average for whole year,	1,037,000	770,000	1,152,000	1,019,000	991,000	1,450,000
Average for driest six months,	237,000	356,000	460,000	314,000	564,000	777,000

MONTH.	1899.	1900.	1901.	1902.	1903.	1904.
January,	2,288,000	794,000	437,000	1,763,000	1,736,000	477,000
February,	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,000
March,	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,999,000
April,	2,521,000	1,350,000	4,204,000	1,885,000	2,261,000	3,294,000
May,	511,000	1,312,000	2,954,000	743,000	351,000	1,745,000
June,	66,000	316,000	753,000	303,000	1,987,000	419,000
July,	19,000	—18,000	306,000	66,000	445,000	62,000
August,	—35,000	—34,000	424,000	135,000	307,000	170,000
September,	94,000	65,000	305,000	178,000	130,000	397,000
October,	115,000	186,000	412,000	506,000	492,000	191,000
November,	304,000	663,000	474,000	444,000	363,000	289,000
December,	220,000	1,096,000	2,695,000	1,779,000	582,000	269,000
Average for whole year,	973,000	1,082,000	1,342,000	1,140,000	1,190,000	931,000
Average for driest six months,	93,000	194,000	445,000	271,000	388,000	228,000

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Concluded.

MONTH.	1905.	1906.	1907.	1908.	1909.	1910.
January,	1,410,000	1,128,000	1,351,000	1,925,000	392,000	1,490,000
February,	330,000	1,041,000	624,000	1,536,000	2,286,000	1,849,000
March,	2,497,000	2,409,000	1,658,000	2,257,000	1,734,000	1,954,000
April,	1,643,000	1,949,000	1,607,000	1,117,000	1,721,000	667,000
May,	297,000	1,059,000	888,000	1,046,000	1,004,000	277,000
June,	467,000	707,000	761,000	194,000	239,000	516,000
July,	177,000	398,000	9,000	—14,000	—121,000	—102,000
August,	114,000	180,000	—104,000	102,000	—45,000	—73,000
September,	1,246,000	19,000	541,000	—82,000	149,000	5,000
October,	158,000	301,000	741,000	47,000	—51,000	—51,000
November,	279,000	483,000	1,998,000	71,000	82,000	176,000
December,	887,000	659,000	2,032,000	136,000	263,000	221,000
Average for whole year,	795,000	860,000	1,010,000	694,000	625,000	570,000
Average for driest six months,	403,000	341,000	471,000	44,000	40,000	29,000

MONTH.	1911.	Mean for 37 Years, 1875-1911.
January,	519,000	1,209,000
February,	700,000	1,735,000
March,	1,144,000	2,790,000
April,	1,426,000	1,989,000
May,	318,000	1,058,000
June,	213,000	507,000
July,	—14,000	166,000
August,	20,000	241,000
September,	76,000	246,000
October,	296,000	449,000
November,	593,000	804,000
December,	908,000	1,016,000
Average for whole year,	514,000	1,013,000
Average for driest six months,	152,000	400,000

NOTE. — The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, due to unavoidable inaccuracies in the measurement of the quantity of water received from the Wachusett Reservoir.

Nashua River.

The average flow of the South Branch of the Nashua River above Clinton during the year 1911 was 682,000 gallons per day per square mile, or 62 per cent. of the normal flow, making the year the driest since the record was begun in 1897 and the fourth successive year in which the average flow has been less than the normal. The flow during the months of October and November was in excess of the normal, but in the remaining ten months of the year it was less than the normal. The greatest excess occurred in November, and the greatest deficiency in March. The average flow for the driest six months, July to December, inclusive, was 327,000 gallons per day per square mile, or 58 per cent. of the normal flow for such a period during the past fifteen years.

In order to show the relation between the flow of the Nashua River during each month of the year 1911 and the normal flow of that stream as deduced from observations during fifteen years, from 1897 to 1911, inclusive, the following table has been prepared. The area of the watershed of the Nashua River above the point of measurement was 119 square miles from 1897 to 1907, inclusive, and 118.19 square miles since the latter year: —

Table showing the Average Monthly Flow of the South Branch of the Nashua River for the Year 1911, in Cubic Feet per Second per Square Mile of Drainage Area, and in Million Gallons per Day per Square Mile of Drainage Area; also, Departure from the Normal Flow.

MONTH.	NORMAL FLOW.		ACTUAL FLOW IN 1911.		EXCESS OR DEFICIENCY.	
	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.
January,	1.875	1.212	1.196	0.773	—0.679	—0.439
February,	2.213	1.430	0.967	0.625	—1.246	—0.805
March,	4.162	2.690	2.073	1.339	—2.089	—1.351
April,	3.328	2.151	2.155	1.393	—1.173	—0.758
May,	1.781	1.151	0.713	0.461	—1.068	—0.690
June,	1.253	0.810	0.543	0.351	—0.710	—0.459
July,	0.643	0.416	0.087	0.057	—0.556	—0.359
August,	0.650	0.420	0.291	0.188	—0.359	—0.232
September,	0.598	0.387	0.281	0.181	—0.317	—0.206
October,	0.849	0.548	1.111	0.718	+0.262	+0.170
November,	1.289	0.833	1.601	1.035	+0.312	+0.202
December,	1.949	1.260	1.650	1.067	—0.299	—0.193
Average for whole year,	1.713	1.107	1.055	0.682	—0.658	—0.425

The following table gives the rainfall upon the Nashua River watershed and the total yield expressed in inches in depth upon the watershed (inches of rainfall collected) for each of the past fifteen years, from 1897 to 1911 inclusive, together with an average for the entire period.

Rainfall, in Inches, received and collected on Nashua River Watershed.

MONTH.	1897.			1898.			1899.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	3.46	1.420	41.0	6.65	2.787	41.9	2.93	3.731	127.3
February,	2.86	1.500	52.4	3.30	2.635	79.8	5.12	1.757	34.3
March,	4.01	4.922	122.7	2.27	5.509	242.7	6.75	4.952	73.4
April,	2.32	2.818	121.5	4.43	3.500	79.0	1.94	5.829	300.5
May,	5.06	2.075	41.0	3.38	2.480	73.4	1.33	1.538	115.6
June,	5.11	2.039	39.9	3.11	1.429	46.0	5.51	0.969	17.6
July,	8.65	2.572	29.7	3.01	0.593	19.7	3.82	0.631	16.5
August,	3.47	1.599	46.1	10.61	2.363	22.3	3.20	0.421	13.2
September,	1.93	0.656	34.0	3.15	1.166	37.0	4.11	0.431	10.5
October,	0.94	0.434	46.2	7.21	2.691	37.3	2.72	0.437	16.1
November,	7.62	2.214	29.1	6.81	3.746	55.0	1.94	0.742	38.2
December,	6.41	4.059	63.3	3.99	3.676	92.1	2.03	0.640	31.5
Totals and averages,	51.84	26.308	50.7	57.92	32.575	56.2	41.40	22.078	53.3

MONTH.	1900.			1901.			1902.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	4.56	1.420	31.1	1.75	0.926	52.9	2.72	2.990	109.9
February,	8.69	6.532	75.2	1.13	0.574	50.8	4.91	2.258	46.0
March,	6.19	6.639	107.3	5.82	4.849	83.3	5.27	7.120	135.1
April,	2.76	2.727	98.8	9.64	8.605	89.3	4.36	3.728	85.5
May,	4.34	2.467	56.8	7.02	4.867	69.3	2.24	1.839	82.1
June,	3.59	0.998	27.8	1.51	1.701	112.6	2.51	0.708	28.2
July,	3.20	0.388	12.1	5.66	0.851	15.0	3.87	0.521	13.5
August,	3.18	0.351	11.0	4.58	0.913	19.9	3.95	0.529	13.4
September,	3.46	0.220	6.4	3.10	0.552	17.8	4.26	0.416	9.8
October,	2.90	0.504	17.4	3.70	1.154	31.2	6.36	1.696	26.7
November,	6.44	1.510	23.4	2.43	0.892	36.7	0.93	1.095	117.7
December,	3.15	2.800	88.9	9.36	5.766	61.6	7.20	3.295	45.8
Totals and averages,	52.46	26.556	50.6	55.70	31.650	56.8	48.58	26.195	53.9

Rainfall, in Inches, received and collected on Nashua River Watershed — Continued.

MONTH.	1903.			1904.			1905.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January, ...	2.85	2.256	79.2	4.02	1.176	29.3	6.10	2.258	37.0
February, . . .	4.42	3.436	77.7	2.66	1.547	58.2	1.72	0.729	42.4
March, ...	6.58	6.107	92.8	3.40	5.361	157.7	3.95	5.358	135.7
April, ...	3.10	3.864	124.6	7.45	5.149	69.1	2.60	2.792	107.4
May, ...	1.24	1.015	81.9	2.99	2.671	89.3	0.83	0.794	95.7
June, ...	10.37	3.678	35.5	3.44	1.315	38.2	4.88	0.935	19.2
July, ...	3.43	1.114	32.5	3.84	0.886	23.1	5.39	0.651	12.1
August, ...	3.88	0.846	21.8	3.68	0.633	17.2	3.09	0.573	18.5
September, . . .	2.93	0.647	22.1	5.30	0.853	16.1	6.90	2.119	30.7
October, ...	4.43	1.228	27.7	1.78	0.620	34.8	1.81	0.654	36.1
November, . . .	2.36	1.095	46.4	1.62	0.591	36.5	2.52	0.763	30.3
December, . . .	3.99	1.702	42.7	2.88	0.784	27.2	3.79	1.816	48.0
Totals and averages, .	49.58	26.988	54.4	43.06	21.586	50.1	43.58	19.442	44.6

MONTH.	1906.			1907.			1908.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January, ...	2.59	2.018	77.9	2.84	2.601	91.6	3.40	3.101	91.2
February, . . .	2.74	1.654	60.4	2.32	1.115	48.0	4.82	2.896	60.0
March, ...	5.17	3.317	64.2	1.82	3.028	166.3	2.77	3.910	141.2
April, ...	3.12	3.640	116.7	2.65	2.479	93.5	2.62	2.191	83.5
May, ...	6.58	2.734	41.5	2.96	1.722	58.2	5.34	2.524	47.3
June, ...	5.95	2.043	34.3	3.54	1.334	37.7	1.29	0.696	54.0
July, ...	5.52	1.299	23.5	3.03	0.597	19.7	3.85	0.393	10.2
August, ...	4.34	1.055	24.3	1.26	0.155	12.3	6.49	0.790	12.2
September, . . .	2.61	0.478	18.3	9.50	1.399	14.7	1.04	0.151	14.5
October, ...	3.95	0.945	24.0	5.68	2.465	43.4	2.12	0.282	13.3
November, . . .	2.25	1.294	57.5	5.74	4.384	76.4	1.05	0.216	20.6
December, . . .	4.26	1.417	33.3	4.40	3.499	79.5	3.03	0.691	22.8
Totals and averages, .	49.08	21.894	44.6	45.74	24.778	54.2	37.82	17.841	47.2

Rainfall, in Inches, received and collected on Nashua River Watershed — Concluded.

MONTH.	1909.			1910.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	3.52	1.056	30.0	5.86	3.293	56.2
February,	6.10	4.119	67.5	5.24	2.972	56.7
March,	4.38	3.798	86.8	1.09	4.708	432.7
April,	5.71	4.181	73.3	3.01	1.785	59.2
May,	2.65	2.162	81.6	2.13	1.085	51.0
June,	3.03	1.090	36.0	4.36	1.422	32.6
July,	4.25	0.416	9.8	1.52	0.110	7.2
August,	3.59	0.345	9.6	3.87	0.332	8.6
September,	3.90	0.358	9.2	2.86	0.250	8.7
October,	1.70	0.160	9.4	1.40	0.122	8.7
November,	1.68	0.626	37.2	4.17	0.612	14.6
December,	4.00	0.958	24.0	2.34	0.697	29.8
Totals and averages,	44.51	19.270	43.3	37.85	17.388	45.9

MONTH.	1911.			MEAN FOR FIFTEEN YEARS, 1897-1911.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	2.91	1.379	47.5	3.74	2.161	57.7
February,	2.43	1.007	41.4	3.90	2.315	59.4
March,	3.79	2.389	63.0	4.22	4.798	113.8
April,	2.22	2.404	108.5	3.86	3.713	96.1
May,	1.59	0.822	51.6	3.31	2.053	62.0
June,	2.37	0.606	25.5	4.04	1.398	34.6
July,	2.53	0.101	4.0	4.11	0.742	18.1
August,	5.46	0.335	6.1	4.31	0.749	17.4
September,	3.04	0.313	10.3	3.87	0.667	17.2
October,	5.24	1.280	24.4	3.46	0.978	28.2
November,	4.14	1.786	43.1	3.45	1.438	41.7
December,	3.01	1.903	63.2	4.26	2.247	52.8
Totals and averages,	38.73	14.325	37.0	46.53	23.259	50.0

The following table gives a record of the yield of the Nashua River watershed for each of the past fifteen years, the flow being expressed in gallons per day per square mile of watershed: —

Yield of the Nashua River Watershed in Gallons per Day per Square Mile.[1]

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.
January,	796,000	1,563,000	2,092,000	796,000	519,000	1,676,000
February,	931,000	1,635,000	1,090,000	4,054,000	356,000	1,401,000
March,	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000	3,992,000
April,	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000
May,	1,163,000	1,390,000	862,000	1,382,000	2,729,000	1,031,000
June,	1,181,000	828,000	561,000	578,000	985,000	410,000
July,	1,442,000	333,000	354,000	217,000	477,000	292,000
August,	896,000	1,325,000	236,000	197,000	512,000	297,000
September,	380,000	676,000	250,000	127,000	320,000	241,000
October,	243,000	1,509,000	245,000	282,000	647,000	950,000
November,	1,283,000	2,170,000	430,000	875,000	517,000	635,000
December,	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,848,000
Average for whole year,	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000
Average for driest six months,	886,000	1,013,000	312,000	377,000	576,000	471,000

MONTH.	1903.	1904.	1905.	1906.	1907.	1908.
January,	1,265,000	659,000	1,266,000	1,132,000	1,458,000	1,738,000
February,	2,133,000	927,000	452,000	1,027,000	692,000	1,736,000
March,	3,423,000	3,008,000	3,004,000	1,860,000	1,697,000	2,192,000
April,	2,238,000	2,984,000	1,617,000	2,109,000	1,436,000	1,269,000
May,	569,000	1,498,000	445,000	1,533,000	965,000	1,415,000
June,	2,131,000	762,000	542,000	1,184,000	773,000	403,000
July,	624,000	497,000	365,000	728,000	335,000	220,000
August,	474,000	355,000	321,000	591,000	87,000	443,000
September,	375,000	494,000	1,228,000	277,000	810,000	88,000
October,	689,000	347,000	367,000	530,000	1,382,000	158,000
November,	634,000	343,000	442,000	749,000	2,540,000	125,000
December,	954,000	440,000	1,018,000	794,000	1,961,000	387,000
Average for whole year,	1,285,000	1,025,000	926,000	1,043,000	1,180,000	847,000
Average for driest six months,	626,000	413,000	541,000	613,000	725,000	238,000

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[1] The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, to 2.4 per cent. in 1903, to 3.6 per cent. in 1904, to 4.1 per cent. in 1905, to 5.1 per cent. in 1906, to 6 per cent. in 1907, and to 7 per cent. in and after 1908.

Yield of the Nashua River Watershed in Gallons per Day per Square Mile — Concluded.

MONTH.	1909.	1910.	1911.	Mean for 15 Years, 1897-1911.
January,	592,000	1,846,000	773,000	1,212,000
February,	2,556,000	1,845,000	625,000	1,430,000
March,	2,129,000	2,639,000	1,339,000	2,690,000
April,	2,422,000	1,034,000	1,393,000	2,151,000
May,	1,212,000	608,000	461,000	1,151,000
June,	632,000	824,000	351,000	810,000
July,	233,000	62,000	57,000	416,000
August,	193,000	186,000	188,000	420,000
September,	208,000	145,000	181,000	387,000
October,	90,000	68,000	718,000	548,000
November,	363,000	354,000	1,035,000	833,000
December,	537,000	391,000	1,067,000	1,260,000
Average for whole year,	918,000	828,000	682,000	1,107,000
Average for driest six months,	271,000	201,000	327,000	567,000

Merrimack River.

The flow of the Merrimack River has been measured for many years at Lawrence, above which place the river has a total watershed area of 4,663 square miles, which includes 118 square miles on the South Branch of the Nashua River, 75 square miles on the Sudbury River and 18 square miles tributary to Lake Cochituate, or a combined area of 211 square miles from which water is drawn at the present time for the supply of the Metropolitan Water District. The flow as measured at Lawrence includes the water wasted from these three watersheds, which, in the wet months of the year, is very considerable, but which becomes very small in the dry months. Records of the quantity of water wasted have been kept by the Boston Water Board and by the Metropolitan Water Board, and these quantities have been deducted from the flow as measured at Lawrence. The area of the three watersheds has also been deducted from the watershed area at Lawrence, so that the net area was 4,570 square miles up to March 1, 1898, at which time the Nashua River was diverted, 4,451 square miles from March 1, 1898, to Jan. 1, 1908, and 4,452 square miles since the latter date.

The average flow of the Merrimack River during the year 1911 was 61 per cent. of the normal flow for the past twenty-four years for which records are available. In 1911 the flow was less than the normal in each of the twelve months of the year, the greatest deficiency occurring in the month of March.

In order to show the relation between the flow of this stream during each month of the year 1911 and the normal flow as deduced from observations during twenty-four years from 1888 to 1911, inclusive, the following table has been prepared: —

Table showing the Average Monthly Flow of the Merrimack River for the Year 1911 in Cubic Feet per Second per Square Mile of Drainage Area; also, the Departure from the Normal.

MONTH.	Normal Flow. Cubic Feet per Second per Square Mile.	Actual Flow in 1911. Cubic Feet per Second per Square Mile.	Excess or Deficiency. Cubic Feet per Second per Square Mile.
January,	1.451	0.624	—0.827
February,	1.422	0.482	—0.940
March,	2.999	1.248	—1.751
April,	3.765	3.045	—0.720
May,	2.310	1.360	—0.950
June,	1.284	0.551	—0.733
July,	0.719	0.266	—0.453
August,	0.651	0.328	—0.323
September,	0.710	0.435	—0.275
October,	0.972	0.918	—0.054
November,	1.249	1.049	—0.200
December,	1.364	1.284	—0.080
Average for whole year,	1.575	0.966	—0.609

Sudbury, Nashua and Merrimack Rivers.

The following table shows the weekly fluctuation during 1911 in the flow of the three streams just described, — namely, the Sudbury River at Framingham, the South Branch of the Nashua River above Clinton and the Merrimack River at Lawrence. The flow of these streams, particularly that of the Sudbury and of the South Branch of the Nashua River, serves to indicate the flow of other streams in eastern Massachusetts. The area of the Sudbury River watershed is 75.2 square miles and of the South Branch of the Nashua River 118.19 square miles. The net watershed area of the Merrimack River is 4,452 square miles.

Table showing the Average Weekly Flow of the Sudbury, South Branch of the Nashua and Merrimack Rivers for the Year 1911 in Cubic Feet per Second per Square Mile of Drainage Area.

WEEK ENDING SUNDAY.	FLOW IN CUBIC FEET PER SECOND PER SQUARE MILE.			WEEK ENDING SUNDAY.	FLOW IN CUBIC FEET PER SECOND PER SQUARE MILE.		
	Sudbury River.	South Branch Nashua River.	Merrimack River.		Sudbury River.	South Branch Nashua River.	Merrimack River.
Jan. 8, . .	1.429	2.028	0.920	July 9, . .	—0.226	0.057	0.220
15, . .	0.593	0.982	0.663	16, . .	—0.192	—0.165	0.348
22, . .	0.268	0.605	0.494	23, . .	—0.347	—0.080	0.190
29, . .	1.057	1.174	0.440	30, . .	0.684	0.473	0.296
Feb. 5, . .	1.587	1.293	0.571	Aug. 6, . .	—0.220	0.073	0.421
12, . .	0.976	0.757	0.538	13, . .	0.011	—0.054	0.315
19, . .	0.468	0.696	0.418	20, . .	0.237	0.321	0.271
26, . .	1.069	0.794	0.432	27, . .	—0.276	0.297	0.283
Mar. 5, . .	0.632	1.024	0.605	Sept. 3, . .	0.394	0.821	0.416
12, . .	0.598	0.785	0.498	10, . .	—0.343	0.286	0.406
19, . .	2.992	2.797	1.342	17, . .	0.220	0.238	0.434
26, . .	1.825	2.049	1.015	24, . .	0.342	0.271	0.450
Apr. 2, . .	2.707	3.583	3.186	Oct. 1, . .	0.262	0.434	0.388
9, . .	3.219	3.412	2.670	8, . .	0.533	0.539	0.636
16, . .	2.653	2.369	3.507	15, . .	0.230	0.384	0.606
23, . .	1.888	1.729	3.177	22, . .	0.740	2.245	1.092
30, . .	1.281	1.254	2.772	29, . .	0.131	1.374	1.443
May 7, . .	0.757	0.764	2.672	Nov. 5, . .	0.889	0.710	0.826
14, . .	0.488	0.513	1.382	12, . .	0.310	1.190	0.927
21, . .	—0.099	0.746	0.925	19, . .	1.262	2.126	1.086
28, . .	1.089	0.872	0.728	26, . .	1.337	2.031	1.289
June 4, . .	—0.364	0.433	0.592	Dec. 3, . .	1.175	1.599	1.238
11, . .	0.912	1.176	0.594	10, . .	0.980	1.027	0.887
18, . .	0.505	0.810	0.655	17, . .	0.758	1.524	1.038
25, . .	0.005	0.068	0.470	24, . .	2.376	2.372	1.308
July 2, . .	0.091	0.131	0.431	31, . .	1.971	1.842	1.869

REPORT

OF THE

LAWRENCE EXPERIMENT STATION

1911.

EXPERIMENTS UPON THE PURIFICATION OF SEWAGE AND WATER AT THE LAWRENCE EXPERIMENT STATION.[1]

By H. W. CLARK and STEPHEN DEM. GAGE.

The following report summarizes the results of the studies upon the purification of sewage and water at the Lawrence Experiment Station during the year ending Nov. 30, 1911. During the year fifty-eight filters have been operated, — twenty-six in studies upon the purification of domestic sewage, two in studies upon the purification of manufactural wastes, nineteen in studies upon nitrification and eleven in studies upon the purification of water.

The investigations in regard to the purification of sewage have included the operation of sand filters which have been in continuous operation for over twenty years, and of contact and trickling filters which have been in operation for ten and twelve years, respectively. These long-term studies are particularly valuable as showing clearly the ultimate destruction of large amounts of organic matter deposited by the sewage within the filter and retained for long periods. Special study has also been made during the past year as to the operation of contact filters in order to determine the effect, as far as the purification of the sewage and the capacity and length of life of such filters is concerned, of different methods of application, of different periods of contact and of varying rates. Studies upon the preliminary clarification of sewage by chemical precipitation, by straining and by sedimentation in open tanks and in tanks filled with slate, have also been in progress, and special attention has been given to the effect of these various preliminary treatments on the subsequent purification of the sewage. An extensive investigation has also been made to determine the effect of carbonaceous matter of different kinds in sewage upon the processes of nitrification in sand filters. Studies upon the disposal of manufactural wastes have been continued, and filters have been operated with the wastes from a tannery and from a rubber mill. An extensive investigation is in progress upon the composition of sewage sludge and manufactural wastes, with particular reference to the recovery of valuable by-products from certain wastes or to their use in the manufacture of fertilizers. The results of a series of investigations upon the disinfection of sewage and the effluents of different types of sewage clarification and purification processes, which have been in progress for a number of years, are summarized in a special article beyond.

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[1] The work has been carried on under the general supervision of Hiram F. Mills, A.M., C.E., member of the State Board of Health, with Mr. H. W. Clark, chemist to the Board, in direct charge. Mr. Stephen DeM. Gage, biologist, and Mr. George O. Adams, chemist, are the principal assistants at the station. A full account of the work done at the Lawrence Experiment Station during the years 1888 and 1889 was contained in a special report of the State Board of Health upon the purification of sewage and water (1890). A similar account for the years 1890 and 1891 is contained in the twenty-third annual report of the Board for 1891. Since 1891 the results have been published yearly in the annual reports; a review of all work at Lawrence upon sewage purification was published in the annual report of the Board for 1908, and the report for 1909 contained a review of the work on factory wastes.

In the investigations on water purification, special study has been made of slow sand filters operated at widely different rates, with particular reference to economy of operation and to the quality of the filtered water. Studies upon the purification of water by precipitation with sulphate of alumina followed by filtration at a high rate through a mechanical filter and by double filtration have been continued, and studies as to the efficiency of an upward-flow roughing filter of coarse material and of a sprinkling filter constructed of sand have been made. The investigations as to the influence of various methods of water purification upon the action of water on metal pipes and plumbing fixtures have been continued throughout the year.

As in previous years, all the general bacterial work of the department of water supply and sewerage has been carried on at the experiment station, and, in addition, a considerable number of bacterial examinations have been made of special samples of sewage, ice and shellfish from various sections of the State. An extended investigation has also been made as to the character of the air in different branches of the textile industry, and as to the effect upon the bacterial content of such air of the quality of water used in supplying artificial humidity.

Furthermore, a large number of the samples of river waters and manufactural wastes, collected during investigations upon the pollution of rivers, have been analyzed in the chemical laboratories at the experiment station.

CHARACTER AND COMPOSITION OF THE SEWAGE USED IN THE EXPERIMENTS.

The sewage used at the experiment station is pumped through a 2½-inch pipe about 4,400 feet long, from the Lawrence Street sewer which drains the streets, houses and stores of the most densely populated section of the city of Lawrence. The inlet to this pipe is located well above the entrance of any of the large mills, and is provided with a strainer with perforations about ¾ of an inch in diameter, by which paper, rags, etc., are largely strained out of the sewage. As received at the station the sewage is a strong, domestic sewage in which the suspended matters have been quite thoroughly disintegrated during their passage through the pipe. This pipe has been in use nearly twenty-five years and is so badly corroded that frequent repairs are necessary. The sewage used in the experiments at Andover is that of a residential town containing little or no manufactural wastes. It is collected by a system of sewers from which street washings and surface water are excluded and into which only a small volume of ground water enters. After being screened through a coarse bar screen it is brought to the filtration area through a long inverted siphon. The sewage as it reaches the filtration area is a very strong, domestic sewage in which more or less putrefactive action has taken place during its passage through the inverted siphon.

The expression "Lawrence Street sewage" means the average of samples collected weekly from the sewer near the inlet of the pipe from which the sewage is pumped; "regular station sewage" is an average of samples collected four times each day at the experiment station on at least four days each week; "sewage applied to Filters Nos. 1, 6 and 9A" is an average of daily samples of all the sewage applied to the large intermittent filters situated out of doors; and "Andover sewage" is an average of weekly samples of the town sewage before it enters the settling tank at the Andover filtration area. It will be noted that the "sewage applied to Filters Nos. 1, 6 and 9A" is somewhat weaker than the "regular station sewage," this being due to the fact that in many instances the volume of sewage required to flood these filters could not be obtained and the deficit was supplied by the admixture of canal water.

The following table gives the average analyses of the various representative samples of sewage collected during the year: —

Lawrence Street Sewage.

[Parts in 100,000.]

Temperature (Degrees F.).	AMMONIA.			KJELDAHL NITROGEN.		Chlorine.	NITROGEN AS		Oxygen consumed.	Bacteria per Cubic Centimeter.
		ALBUMINOID.								
	Free.	Total.	In Solution.	Total.	In Solution.		Nitrates.	Nitrites.		
62	2.18	0.73	0.44	2.68	1.67	15.58	.05	.0060	7.51	2,033,100

Regular Station Sewage.

-	3.52	0.48	0.27	0.98	0.56	12.95	-	-	3.57	2,006,700

Sewage applied to Filters Nos. 1, 6 and 9A.

[Parts in 100,000.]

Temperature (Degrees F.).	Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Nitrogen as		Oxygen consumed.	Bacteria per Cubic Centimeter.
		Albuminoid.								
	Free.	Total.	In Solution.	Total.	In Solution.		Nitrates.	Nitrites.		
-	3.11	0.40	-	0.79	-	11.12	-	-	3.06	-

Andover Sewage.[1]

57	6.11	1.28	0.51	2.91	1.18	7.49	-	-	7.93	4,825,000

[1] April to November, inclusive.

PRELIMINARY TREATMENTS FOR CLARIFICATION OF SEWAGE.

Studies upon the clarification of sewage as a preliminary to filtration by sedimentation, in open tanks, in a tank filled with layers of slate, and by straining through a layer of anthracite coal, have been continued during 1911, and certain experiments upon chemical precipitation have been resumed.

Sedimentation in Open Tanks.

The large settling tank installed in 1906 for the clarification of sewage to be applied later to trickling and contact filters has been continued in operation at the station. This is a cylindrical tank with a sloping bottom into which the sewage enters near the bottom and rises slowly to an outlet near the top; the period of sedimentation while sewage is flowing through the tank is about two hours and the vertical velocity is about 1 inch per minute. As originally constructed, the bottom of this tank had a slope of about 17°, which proved to be much too flat, making it necessary to empty the tank and remove the accumulated sludge each week. During July the tank was rebuilt with a conical bottom sloping at an angle of 60°. With the steeper pitch, it is found that the deposited sludge slides down to the blow-off valve at the bottom where it is easily blown out without draining the tank. During the latter part of the year it has been the practice to blow off the accumulated sludge about three times a week. The average removal of suspended matter by this tank during the year has been about 45 per cent., as shown by Kjeldahl nitrogen in suspension, and about 65 per cent. and 58 per cent., as shown by the total and organic solids in suspension, respectively. The total removal of organic matter has been about 29 per cent., as shown by the total Kjeldahl nitrogen, and about 23 per cent., as shown by total organic solids.

The work of the settling tank at the Andover filtration area has been studied as in previous years. This tank has a capacity of about 13,500 gallons, and the average time required for the sewage to pass through it is approximately two hours. The average removal of suspended matters by this tank during the period from April to November, 1911, inclusive, during which samples were collected regularly, was about 64 per cent., as shown by Kjeldahl nitrogen in suspension, and the average removal of total organic matters was about 43 per cent., as shown by determinations of both Kjeldahl nitrogen and oxygen consumed.

Sedimentation in Tanks filled with Layers of Slate.

Tank No. 376, having a superficial area of $\frac{1}{4200}$ of an acre, was first put into operation on July 9, 1909. The tank contains 27 horizontal layers of roofing slate spaced $\frac{3}{4}$ of an inch apart and separated by small concrete blocks. The exposed surface available for the deposition and destruction of sludge is about 314 square inches for each gallon of sewage contained within the tank. This tank has been operated like a contact filter, being completely filled with sewage once each day, the sewage being then allowed to stand quiescent in the tank one hour before being drawn off. The sludge, which, owing to the arrangement of slate layers is deposited in thin films, is allowed to remain in the tank for digestion. When the outlet of the tank is opened a small amount of sludge usually comes away with the first portions of the effluent. At the end of the year the accumulated sludge occupied about 9 per cent. of the original capacity of the tank, there being practically no reduction in capacity during the year. The average removal of suspended matter from the sewage by this tank was about 41 per cent., as shown by total solids in suspension, and about 44 per cent., as shown by volatile solids in suspension. The total removal of organic matter was only 19 per cent., as shown by total organic solids, and 9 per cent., as shown by determinations of Kjeldahl nitrogen.

In discussing the results obtained during 1909 with Tank No. 376 it was stated on page 291 of the report for that year that "it will be observed that there has been practically no nitrification within the filter, and this was not to be expected. These so-called filters are simply contrivances to remove, and, if possible, destroy sludge by biological action." On page 251 of the report for 1910 it was stated that "judging from the results during the year, and from the experience obtained with similar filters operated in 1901 and 1902, filters or tanks of this kind cannot be expected to accomplish more than a preliminary clarification of sewage, and for this reason they should perhaps be classed and compared in efficiency with other clarification treatments." It is interesting to compare these statements and the results obtained with Filter No. 376 with the following quotations from the Seventh Report of the Royal Commission on Sewage Disposal, 1911, upon the slate bed process in England, where a number of beds of this type have been tried out on a practical scale during the past few years.

> On Dec. 18, 1908, Mr. Dibdin submitted a list of places at which slate beds had been installed. Three installations, namely, those at Devizes, East Dereham and Machynlleth, were selected from this list as being the most suitable for observation. . . . The working of the slate beds at each of these three places was kept under observation for rather more than a year. . . .
>
> In the fifth report, page 67, the commission made the following statement with regard to slate beds: —
>
>> As the result of our inspection of the beds at Devizes we came to the tentative conclusion that primary beds containing large slabs of slate must be regarded more as preliminary settling or septic tanks than as contact beds.
>
> As regards the effluent which results from the treatment of sewage in slate beds, this conclusion has been borne out by the observations which have since been made.
>
> The effluent from a slate bed is, for practical purposes, indistinguishable from a tank effluent. It contains about the same amount of suspended matter, and requires subsequent treatment similar to that which would be necessary for a tank effluent from the same sewage. . . .
>
> The capacity of a new slate bed is about 85 to 90 per cent. of the capacity of the empty tank.
>
> From the measurements of the capacity of the slate beds at the three places under observation it is clear that the greater part of this capacity can be maintained permanently if the sludge which collects in the beds is habitually allowed to come away after the beds have been run off. . . .
>
> It has been calculated that the average rate of loss of capacity in the Devizes slate beds during the first five years of their life was only about 100 gallons per million gallons of sewage treated. . . .
>
> The average rate of loss of capacity at Machynlleth has been estimated at about 48 gallons per million gallons of sewage treated. As already stated, however, the sewage is partially settled before being sent into the slate beds.
>
> At Dereham, where, in order to prevent clogging of the contact beds, the sludge has been purposely retained in the slate beds, there was a serious loss of capacity. . . .

In this case the average rate of loss of capacity was 1,126 gallons per million gallons of sewage treated. . . .

It may be taken broadly that between 40 and 60 per cent. of the suspended matter of an average sewage is mineral.

Of the remainder, a considerable proportion consists of cellulose and other matter which is known to decompose under biological action only very slowly at ordinary temperatures.

It is clear, therefore, that the maximum digestion of sewage-suspended matter which could be anticipated from any biological process would be considerably less than 50 per cent., even under the most favorable circumstances. . . .

From the data which have been obtained with regard to Devizes, however, the digestion, or, more correctly, the diminution in solids, which takes place in the slate beds there, would appear to be very small. The actual figure obtained was only 1 per cent. of the total suspended solids.

Although it is possible to work slate beds in such a manner as to postpone for a considerable time the necessity for dealing with any sludge, it appears to us that the practice is not likely to prove economical.

Chemical Precipitation.

During 1911 the studies upon clarification of sewage by chemical precipitation which were in progress from 1889 to 1897, but which had been discontinued, were resumed. Since Feb. 1, 1911, sewage has been treated daily with sulphate of alumina in the proportion of 714 pounds per million gallons (5 grains per gallon), a period of four hours being allowed for sedimentation before drawing off the clarified supernatant sewage from the precipitated sludges. The removal of suspended organic matters from the sewage by this process, as shown by determinations of loss on ignition, has varied from 10 per cent. to over 97 per cent. at different times, and has averaged about 77 per cent. during the ten months since the studies were resumed. The average removal of nitrogenous matters in suspension has been about 64 per cent., as shown by Kjeldahl nitrogen determinations. The total removal of organic matters has averaged about 48 per cent., as shown by loss on ignition, and 49 per cent. and 52 per cent., respectively, as shown by oxygen consumed and Kjeldahl nitrogen determinations.

Straining through Anthracite Coal.

Strainer E, containing 12 inches in depth of buckwheat coal, was first put into operation on Feb. 1, 1901. From December 1 to March 1 this strainer was operated at a rate of 800,000 gallons per acre daily, and during the remainder of the year at a rate of 1,000,000 gallons per acre daily.

There was no removal of sludge, nor was any surface treatment given to this strainer throughout the year; in fact, from Jan. 28, 1910, to the end of 1911 no attention was required by this strainer except the daily application of sewage. As pointed out in the last report, the work of this strainer year after year in removing and disposing of large amounts of suspended matters with scarcely any mechanical assistance is extremely remarkable. On April 1, 1902, the surface was scraped. Since that time, however, the surface has not been scraped and has been raked only once in order to relieve clogging. During the nine and two-thirds years since it was last scraped, about 107,000 gallons of sewage have been clarified on this small strainer only 20 inches in diameter, and about 130 pounds of suspended solid matters have been removed from the sewage and stored within or digested by the strainer during this time. Assuming that this suspended matter was stored in or upon the surface of the filter as sludge containing 90 per cent. of water, it would occupy a volume over 6 times that occupied by the entire body of material and underdrains within the strainer, or would form a layer about 10 feet thick over the surface of the material.

The average removal of suspended matter by this strainer during the year has been about 72 per cent. as shown by Kjeldahl nitrogen in suspension, and about 69 per cent. and 71 per cent., respectively, as shown by the total and organic solids in suspension. The total removal of organic matter has been about 36 per cent. as shown by the total Kjeldahl nitrogen, and about 29 per cent. as shown by total organic solids.

Average analyses of the sewage after clarification by settling, chemical precipitation and straining are shown in the following tables: —

Settled Station Sewage.

[Parts per 100,000.]

Temperature (Degrees F.).	APPEARANCE.		AMMONIA.			KJELDAHL NITROGEN.		Chlorine.	NITROGEN AS		Oxygen consumed.	Bacteria per Cubic Centimeter.
				ALBUMINOID.								
	Turbidity.	Color.	Free.	Total.	In Solution.	Total.	In Solution.		Nitrates.	Nitrites.		
65	-	-	3.24	0.35	0.22	0.70	0.47	12.63	-	-	2.62	1,678,500

Andover Settled Sewage.

57	-	-	4.42	0.77	0.48	1.67	1.06	8.17	-	-	4.54	2,815,600

Effluent from Slate Tank No. 376.

[Parts per 100,000.]

Temperature (Degrees F.).	Appearance.		Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Nitrogen as		Oxygen consumed.	Bacteria per Cubic Centimeter.
				Albuminoid.								
	Turbidity.	Color.	Free.	Total.	In Solution.	Total.	In Solution.		Nitrates.	Nitrites.		
-	5.5	.75	3.20	0.54	0.35	1.03	-	13.66	0.10	.0053	3.44	992,500

Chemically Precipitated Sewage.

-	-	-	2.57	0.24	0.16	0.46	0.31	11.76	-	-	1.79	626,500

Effiuent from Strainer E.

-	-	-	2.28	0.32	0.24	0.63	0.50	11.96	-	-	2.58	1,067,800

Average Solids.

Settled Station Sewage.

[Parts per 100,000.]

Unfiltered.			Filtered.			In Suspension.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
50.1	17.1	33.0	-	-	-	-	-	-

Effluent from Slate Tank No. 376.

59.5	22.3	37.2	49.6	15.3	34.3	9.9	7.0	2.9

Chemically Precipitated Sewage.

43.5	11.3	32.2	40.3	9.3	31.0	3.2	2.0	1.2

Effluent from Strainer E.

49.4	15.8	33.6	46.0	13.2	32.8	3.4	2.6	0.8

INTERMITTENT SAND FILTERS OPERATED WITH UNTREATED SEWAGE.

Filters Nos. 1, 2, 4, 5C, 6, 9A and 10.

These seven sand filters are each $\frac{1}{200}$ of an acre in area and are situated out-of-doors. Filters Nos. 1, 2, 4 and 6 have been operated continuously for nearly twenty-four years, and Filters Nos. 9A and 10 have been operated twenty-one and seventeen years, respectively. Sewage without any form of preliminary clarification has always been applied to these filters, and since 1893, a period of about eighteen years, they have been operated without the removal of any sand from the surface.

For some years it has been the practice to apply only as much sewage to each filter as can be treated without increasing the amount of organic matter stored within the filter. During recent years the surfaces of Filters Nos. 1, 5C, 6 and 9A have been trenched during the winter and leveled during the summer, the sewage being applied in the trenches in winter and distributed over the entire surface during the summer. The surfaces of Filters Nos. 2 and 4, which are constructed of fine material, are arranged in circular trenches which are filled with coarser material. The trenches in Filter No. 2 are 1 foot wide and 2 feet deep and are filled with sand of an effective size of 0.19 millimeter, while those in Filter No. 4 are about 14 inches wide and 1 foot deep and are filled with sand of an effective size of 0.48 millimeter, the surface of the sand in the trenches of each filter being below that of the remainder of the filter. The sewage is applied to these trenches of coarser sand throughout the year, and on the ridges between the trenches grass is allowed to grow during the summer. During the winter season the surfaces of all of these filters have been protected to some extent by loose board covers laid over the trenches. Filter No. 10 differs from the other filters in that no underdrains are beneath the sand except immediately around the outlet pipe. A partition extending 3 feet below the surface of this filter separates the quarter of the surface which is farthest from the underdrains from the remainder of the surface, and to this quarter of the surface the sewage is applied, the other three quarters being covered with a layer of loam 8 inches in depth, except for a strip about 2 feet wide extending across the filter, which is left open to provide ventilation. Unlike the other large filters at the station, the surface of Filter No. 10 is neither trenched nor protected by board covers during the winter.

The depth and size of sand of which each of these filters is constructed, the date when started, and the total volume of sewage treated during the entire period of operation of each filter are shown in the following table: —

Filter Number.	Depth (Feet).	Effective Size of Sand (Millimeter).	Date First operated.	Actual Volume of Sewage applied since Start (Gallons).
1,	5	0.48	Jan. 10, 1888	2,466,282
2,	5	0.08	Dec. 19, 1887	1,356,756
4,	5	0.04	Dec. 19, 1887	838,376
5C,	5	0.22	July 20, 1905	481,500
6,	3⅔	0.35	Jan. 12, 1888	2,001,754
9A,	5	0.17	Nov. 18, 1890	2,012,319
10,	5	0.35	July 18, 1894	710,835

During 1911 regular station sewage has been applied six days each week to Filters Nos. 1, 5C, 6 and 9A at a rate of 50,000 gallons per acre daily; to Filter No. 2 at a rate of 40,000 gallons per acre daily; and to Filter No. 10 at a rate equivalent to 30,000 gallons per acre daily for the entire surface, or 120,000 gallons for the quarter of the surface flooded. Regular station sewage has been applied to Filter No. 4 three days each week at a rate of 40,000 gallons per acre daily.

From December 2 to March 14 the trenches of all the filters except Filter No. 10 were covered with boards. On March 31 the surface of that portion of Filter No. 10 to which sewage was applied, and the sand in the trenches of each of the other filters, was dug over to a depth of 6 inches, and the surfaces of Filters Nos. 1, 5C, 6 and 9A were leveled and dug over to a depth of 10 inches. On October 27 the sand in the trenches of Filters Nos. 2 and 4, and in the portion of Filter No. 10, to which sewage is applied, and the entire surface of the other filters was dug over from 6 to 8 inches deep, and on November 20 the surfaces of Filters Nos. 1, 5C, 6 and 9A were trenched for the winter. That portion of the surface of each filter to which sewage was applied was raked 1 inch deep five times during the period from December 1 to April 1, and once each week during the remainder of the year. On June 5 the grass on the ridges in Filters Nos. 2 and 4 was cut. All the filters were allowed to rest from May 25 to June 4, inclusive, and from October 26 to November 1, inclusive. A total depth of 34 inches of snow and about ¾ of an inch of ice were removed during the winter from the surface of Filter No. 10, which was unprotected by board covers. During July, August and the early part of September there was a shortage in the supply of sewage owing to trouble with the pipe through which sewage is brought to the station, and the sewage applied to these filters was diluted with canal water a number of times, this accounting for the somewhat weaker character of the applied sewage during this period.

The work of these filters, as in previous years, since the practice of applying only so much organic matter as could be assimilated by the filter was introduced, has been eminently satisfactory. Examinations of the filter materials show that there has been no appreciable accumulation of organic matters within the filters, the accumulation of freshly deposited matters being balanced by the working over and reduction of the stored matters. Nitrification has been active in all of the filters throughout the year. As has been frequently stated in previous reports, however, there is much difference in the work of the individual filters at different seasons of the year, this being particularly noticeable in the amount of nitrates in the effluents from the various filters at different times. As is usual in out-of-door filters, nitrification was less active in the winter than during the summer in all the filters, the fluctuation in the amount of nitrification being much less in the filters of fine material, however, than was the case with the filters of coarser sand operated at higher rates.

The degree of purification, as has been pointed out in previous reports, is less in winter than in summer, much of the organic matter applied in winter being stored within the filter, and much being carried only to the ammonia stage instead of being completely oxidized to nitrates. With the beginning of warm weather the decomposition of the stored matter begins, as is shown by excessively high nitrates combined with comparatively high free ammonia, this stage being followed by a large decrease in the free ammonia with continued high nitrates as soon as the more easily oxidized stored matters have been worked over. While these various stages are to be observed in all of these out-of-door filters, the differences are much more strongly marked in the filters of coarse sand than in those constructed of fine material.

The average analysis of the effluent from each of these filters during the year is shown in the following table: —

Average Analyses.

Effluent from Filter No. 1.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily for Six Days in a Week.	TEMPERATURE (DEG. F.).		Length of Time Sewage remained on Surface (Minutes).	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.	Bacteria per Cubic Centimeter.
	Sewage.	Effluent.		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.			
45,300	58	53	37	0.4	.28	.6716	.0566	10.21	3.12	.0005	.60	0.1	10,500

Average Analyses — Concluded.

Effluent from Filter No. 2.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature (Deg. F.).		Length of Time Sewage remained on Surface (Minutes).	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.	Bacteria per Cubic Centimeter.
	Sewage.	Effluent.		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.			
36,900	58	52	41	0.0	.12	.1148	.0222	9.77	2.82	.0098	.27	1.0	1,800
Effluent from Filter No. 4.													
18,700	58	51	22	0.0	.09	.1081	.0187	9.10	2.72	.0262	.21	0.6	820
Effluent from Filter No. 5C.													
45,900	58	54	17	0.3	.28	.6623	.0498	9.80	3.00	.0012	.58	0.1	12,800
Effluent from Filter No. 6.													
45,200	57	54	46	0.3	.26	.5881	.0530	10.24	3.27	.0014	.48	0.8	17,000
Effluent from Filter No. 9A.													
45,700	57	55	62	0.1	.29	.4976	.0430	10.58	2.68	.0002	.56	0.1	2,500
Effluent from Filter No. 10.													
27,300	58	55	50	0.2	.26	.4785	.0543	10.22	1.92	.0009	.55	0.3	5,300

INTERMITTENT SAND FILTERS OPERATED WITH CLARIFIED SEWAGE.

Filters Nos. 429, 430, 431 and 432.

In previous reports it has been stated frequently that there is a certain normal rate at which a sand filter may be operated scientifically in order to produce an effluent of good quality with the complete, or practically complete, destruction of the organic matter by natural means without mechanical assistance, and that that rate is governed by the amount of organic matter, and especially by the organic matter in suspension which is carried by the sewage. If this statement be true — and its truth has been established by numerous experimental data obtained at the station during the past twenty years — the effective rate of a filter should be established on the basis of the quantity of organic matter applied, and it should be possible to operate a series of filters with sewage from which greater or less proportions of the organic matter have been removed by different processes, in such a manner that the ultimate results would be the same, simply by adjusting the rates of the different filters in such proportion that the same amount of organic matter be applied to each.

On Feb. 1, 1911, four filters, Nos. 429, 430, 431 and 432, were put into operation to study the practical application of this basic principle. Each of these filters is $\frac{1}{20000}$ of an acre in area and is constructed of 5 feet in depth of sand of an effective size of 0.25 millimeter over the usual underdrains. Regular station sewage was applied to Filter No. 429 at a rate of 100,000 gallons per acre daily from February 1 to May 31, and at a rate of 80,000 gallons per acre daily during the remainder of the year. Each of the other filters has received the same sewage after a portion of the organic matters has been removed, Filter No. 430 receiving settled sewage, Filter No. 431 receiving sewage which has been strained through a layer of buckwheat coal, and Filter No. 432 receiving sewage which has been clarified by chemical precipitation, the volume of clarified sewage applied to each of these filters being so adjusted that the total amount of organic matter applied to each should be the same as that applied to Filter No. 429 which received the unclarified sewage. As a convenient and quickly determined basis of comparison, the total nitrogen of these various sewages has been used to compute the rates of the filters receiving clarified sewage, and those rates have been fluctuated from time to time as the nitrogen of the different sewages varied. The average rate of Filter No. 429 was 84,700 gallons per acre daily, and the regular sewage applied to that filter contained on an average 0.85 part per 100,000 total nitrogen. The average rate of Filter No. 430 was 122,200 gallons per acre daily, and the settled sewage applied contained 0.61 part per 100,000 total nitrogen. The average rate of Filter No. 431 was 127,200 gallons per acre daily and the average amount of nitrogen in the strained sewage applied was 0.58 part per 100,000. The average rate of Filter No. 432 was 155,900 gallons, and the chemically precipitated sewage applied contained about 0.46 part per 100,000 total nitrogen. The product of these average rates in thousand gallons by the average total nitrogen in the sewage applied is the average units of nitrogen applied to each filter. The average number of such units of nitrogen applied per day during the year was practically the same for each of these filters, Filters Nos. 429 and 432 receiving 72 units of nitrogen each per day, and Filters Nos. 430 and 431 receiving 74 units of nitrogen per day. Nitrification commenced in all of these filters shortly after they were started, and was active throughout the year. The average nitrification by the filter receiving the untreated sewage was somewhat greater than that of the other three filters which received clarified sewage, the average nitrification of the three latter being practically the same. At the end of the year analyses of the sand showed that the amount of nitrogenous matter stored in each of these filters was practically the same.

The average analyses of the applied sewages and effluents from these filters are shown in the following tables: —

Average Analyses.

Untreated Sewage applied to Filter No. 429.

[Parts in 100,000.]

Ammonia.			Kjeldahl Nitrogen.				
	Albuminoid.						
Free.	Total.	In Solution.	Total.	In Solution.	Chlorine.	Oxygen consumed.	Bacteria per Cubic Centimeter.
2.99	.47	.30	.85	.58	11.90	3.18	2,061,900

Settled Sewage applied to Filter No. 430.

Free.	Total.	In Solution.	Total.	In Solution.	Chlorine.	Oxygen consumed.	Bacteria per Cubic Centimeter.
2.55	.31	.24	.61	.46	13.24	2.59	1,583,100

Strained Sewage applied to Filter No. 431.

Free.	Total.	In Solution.	Total.	In Solution.	Chlorine.	Oxygen consumed.	Bacteria per Cubic Centimeter.
2.40	.31	.23	.58	.47	12.77	2.50	1,121,600

Chemically Precipitated Sewage applied to Filter No. 432.

Free.	Total.	In Solution.	Total.	In Solution.	Chlorine.	Oxygen consumed.	Bacteria per Cubic Centimeter.
2.57	.24	.16	.46	.31	11.76	1.79	626,500

Average Analyses.

Effluent from Filter No. 429.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.	Bacteria per Cubic Centimeter.
		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.			
84,700	64	0.0	.05	.3524	.0199	11.28	3.23	.0081	.18	0.2	1,325
Effluent from Filter No. 430.											
122,200	64	0.0	.06	.2858	.0200	13.03	2.84	.0023	.17	0.5	1,220
Effluent from Filter No. 431.											
127,200	64	0.0	.06	.3033	.0199	12.62	2.74	.0034	.15	0.8	1,285
Effluent from Filter No. 432.											
155,900	64	0.0	.06	.6450	.0283	10.33	2.83	.0033	.19	0.7	8,430

OPERATION OF TRICKLING FILTERS.

Filters Nos. 135, 136, 222, 248 and 360.

During 1911 five trickling filters have been in operation, — four, Nos. 135, 136, 248 and 360, at the station, and one, No. 222, at Andover. Two of these filters, Nos. 135 and 136, have been in continuous operation over twelve years, and one, No. 248, has been operated continuously for over seven years.

All of the four filters operated at the station have received settled sewage at a rate of 2,000,000 gallons per acre daily, Filters Nos. 135 and 136 being operated seven days each week, with a rest of one hour each morning and afternoon, and the other two filters being operated continuously during the first six days of each week and allowed to rest on Sunday. The sewage is uniformly distributed over the surface of each of these filters by automatic tipping basins discharging into perforated pans. Filters Nos. 135, 136 and 248 are each constructed of broken stone of such size that all the pieces will pass through a screen with a 1-inch mesh, and only 4 per cent. through a screen with a $\frac{1}{4}$-inch mesh. Each of these filters is $\frac{1}{20000}$ of an acre in area and contained in tanks with openings for ventilation in the sides. Filters Nos. 135 and 136 are each 10 feet deep and were first put into operation in November, 1899. Filter No. 248, first put into operation in May, 1904, originally contained 8 feet in depth of material, but on Jan. 6, 1911, this depth was reduced to 6 feet. Filter No. 360 is square in section, has a superficial area of $\frac{1}{10000}$ of an acre, and is constructed of 8 feet 9 inches in depth of pieces of broken stone having a mean diameter between 1 and 2 inches, held in place by open cob-work sides. This filter was first put into operation in November, 1908.

Filter No. 222 is located at the Andover filtration area, is $\frac{1}{200}$ of an acre in area, and was first put into operation in April, 1903. In April, 1906, the filter was rebuilt, and at present consists of 6 inches in depth of cobblestones above Akron pipe underdrains, overlaid with 7 feet of broken stone, all of which will pass through a screen with a 1½-inch mesh and none of which will pass through a screen with a ¾-inch mesh. The depth of the filtering material is greater than the depth of the tank, the upper 2 feet of material being held in place by a cobblestone wall. Andover settled sewage has been applied to this filter seven days each week from April 1 to the end of the year, at a rate of 1,500,000 gallons per acre daily, by means of a self-propelled traveling distributor of the Fiddian type, a description of which was given on page 293 of the report for 1909.

The work of all these trickling filters during the past year has been quite satisfactory, and all have produced effluents at all times which have been highly nitrified. The work of the individual filters, however, has varied considerably. Of the two older filters, Nos. 135 and 136, which are identical in age, in depth and in character of filtering material, and which have been operated throughout the year under identical conditions, the effluent from Filter No. 135 has always been more highly nitrified and has contained a less amount of free ammonia than has the effluent from Filter No. 136. The previous history of these filters, however, has not been the same, and this may account, at least in part, for the variation in their work. The effluents from both have been entirely stable at all times throughout the year. The effluent from Filter No. 248, constructed of the same material as Filters Nos. 135 and 136, but of less depth, has contained less nitrates and more free ammonia than the effluents from the deeper filters. It has been demonstrated frequently at the station that, other things being equal, the depth of a filter is an important factor in determining the degree of nitrification produced by that filter. The effluent from this filter was putrescible for a short period during January and February, but has been entirely stable during the remainder of the year. The effluent from Filter No. 360, constructed of stone much larger in size than that in the other three filters, has produced an effluent which is less highly oxidized than that obtained from the filters of finer material. This result is also in accordance with those obtained with these and other filters during previous years. As explained in previous reports, the underdrain system of Filter No. 360 is divided into three distinct collecting areas of equal size, and during the present year separate samples have been collected from each of these underdrains in order to study as far as was possible in this small filter the fluctuations and variations in the character of the effluent from different portions of the same filter. Average analyses of the separate portions collected from these different underdrains, as well as averages of the entire effluent, are shown in the following tables, the various samples being designated 360A, 360B, 360C and 360. The effluents from these different sections of the same filter have differed considerably in quality at different times during the year. As a rule, however, the highest degree of nitrification has been obtained in one or the other of the outside sections where there has been the greatest exposure to the outside air. The averages show slightly higher nitrates and somewhat less free ammonia in the effluent from Section C than in the effluent from Section A, in which the exposure to the air was the same. The effluent from Section C has also been somewhat more stable than that from Section A, although the effluents from each of the sections were putrescible 40 to 50 per cent. of the time throughout the year. It is possible that the somewhat varied work of these different sections of the same filter may be explained by the previous history of these sections, as was stated above in discussing the relative purification by Filters Nos. 135 and 136. In previous years Filter No. 360 was used in a study upon the effect of unequal distribution, sewage being applied to Section A at a much higher rate than to Section B. It may be that the processes already established in these two sections were somewhat different, or what is more probable, that the load of stored organic matter in one section was greater than in the other. The average differences in the work of the sections are too small, however, to permit definite conclusions to be drawn. It will be interesting to observe the behavior of this filter during the next few years.

The work of Filter No. 222 during the past summer has been quite satisfactory. Nitrification commenced almost immediately after the filter was started in April, and increased rapidly, and except for a few samples tested during June, and on one sample collected in October and one in November, the results of putrescibility tests have been negative throughout the year. The good work of this filter during the past few summers when a practically uniform distribution of the sewage has been practiced, as compared with the poor work during earlier years, and the relative freedom of surface clogging during these recent years, continues to demonstrate the necessity for good distribution of the sewage upon filters of this type. It is apparent, however, that a distributor of the type used on this filter, while supplying a very uniform distribution of the sewage, is not entirely practicable for this climate, for in previous years the operation of the apparatus has been stopped by a heavy fall of snow. It has been suggested that it might be feasible to keep such an apparatus in operation during the winter by constructing a rough roof over the filter. In the early part of December, 1910, at a time when the temperature ranged from 10° to 20° F. and there was no snow to interfere, it was attempted to keep the distributor in operation. Although the temperature of the sewage was well above freezing, anchor ice gradually accumulated until the buckets on the apparatus were completely filled and the operation of the apparatus was effectually prevented. It is probable, therefore, that during extremely cold weather it would not be possible to keep a distributor of this type in operation continuously, even if the apparatus were protected from heavy snow by covering the filter.

The average analyses of the effluents from these various trickling filters are shown in the following tables: —

Average Analyses.

Effluent from Filter No. 135.

[Parts in 100,000.]

Quantity applied. — Gallons per Acre Daily.	Appearance.		Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Nitrogen as		Oxygen consumed.	Bacteria per Cubic Centimeter.
				Albuminoid.							
	Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.		
1,966,000	2.2	.44	0.3794	.1896	.1068	.3535	12.54	3.22	.0037	1.55	37,800

Effluent from Filter No. 136.

1,956,500	2.7	.49	.6379	.1871	.1248	.3537	12.51	2.08	.0053	1.59	120,600

Effluent from Filter No. 222.

1,500,000	-	.33	1.5958	.3944	.1464	.7778	8.40	1.51	.0226	2.10	250,900

Effluent from Filter No. 248.

1,636,000	3.0	.56	1.0927	.3825	.1808	.7611	12.73	1.60	.0145	2.54	323,600

Average Analyses — Concluded.

Effluent from Filter No. 360 (Section A).

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	Appearance.		Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Nitrogen as		Oxygen consumed.	Bacteria per Cubic Centimeter.
				Albuminoid.							
	Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.		
–	3.4	.65	1.3669	.3031	.1739	.5442	13.24	1.05	.0120	2.16	496,800

Effluent from Filter No. 360 (Section B).

–	3.4	.66	1.1054	.3005	.1936	.5352	12.64	1.03	.0141	2.14	474,500

Effluent from Filter No. 360 (Section C).

–	3.4	.65	1.1744	.2938	.1952	.5836	12.69	1.28	.0133	2.18	431,800

Effluent from Filter No. 360 (Entire Filter).

1,315,700	3.4	.65	1.2156	.2991	.1876	.5543	12.86	1.12	.0131	2.16	329,400

Stability of Effluents from Contact and Trickling Filters, 1911.

Filter.	Nitrates, Parts per 100,000.	Number of Samples.	Per Cent. of Samples.		
			Putrescible.	Doubtful.	Stable.
Contact Filter No. 175,	0.26	32	15.6	0.0	84.4
Trickling filters: —					
No. 135,	3.22	33	0.0	0.0	100.0
136,	2.08	33	0.0	0.0	100.0
222,	1.51	27	14.8	3.7	81.5
248,	1.60	32	12.5	0.0	87.5
360A,	1.05	33	36.4	12.1	51.5
360B,	1.03	33	27.2	15.2	57.6
360C,	1.28	33	24.2	15.2	60.6

OPERATION OF CONTACT FILTERS.

Filters Nos. 175 and 421 to 428, inclusive.

During 1911 nine contact filters have been in operation. One of these, No. 175, has been operated continuously for about eleven years. The other eight filters were started during the year to study comparatively the effect of various methods of operation upon the purification accomplished by filters of this type. Filter No. 175, first put into operation on June 3, 1901, is 5 feet in depth and is constructed of pieces of coke of such size that all will pass through a sieve having a 1-inch mesh, 75 per cent. through a ½-inch mesh, and practically none through a sieve with a ¼-inch mesh. This filter has always received sewage that has passed through a coke or coal strainer. It is filled once daily in one dose, allowed to stand full two hours before draining, and is allowed to rest every sixth week. The average rate of operation during 1911 was about 318,000 gallons per acre daily. At the beginning of the year about 51 per cent. of the original open space of this filter was occupied by deposited matters. As has been noted for a number of years, this open space gradually decreased during the winter and spring months, and then gradually increased until the end of the year, with the result that the reduction in open space during the year was only about 1 per cent. The purification by this filter during the latter portion of the year has been far from satisfactory. The effluent has been discolored with iron, nitrates have been very low and the free ammonia has been high, showing that a reducing action was taking place within the filter. Shortly after the end of the year the coke in the filter was removed, washed and replaced in a new tank. The relative amount and composition of the deposited matters in different parts of the filter are shown in the following table: —

	POUNDS PER ACRE (DRY WEIGHT).			
	Upper Third.	Middle Third.	Bottom Third.	Total.
Total solids,	100,000	184,000	175,000	459,000
Volatile solids,	42,800	78,300	70,500	191,600
Fixed solids,	57,200	105,700	104,500	267,400
Nitrogen as free ammonia,	36	36	50	122
Organic nitrogen,	1,795	2,130	2,040	5,965
Fats,	775	1,110	606	2,491

Filters Nos. 421 to 428, inclusive. — On Jan. 18, 1911, eight contact filters were started to study comparatively the effect of various methods of operation upon the purification accomplished and upon the clogging of such filters. Each of these filters is $1/20000$ of an acre in area, and is constructed of 33 inches in depth of pieces of soft coal cinders having a diameter between ¼ and 1¼ inches. Settled sewage was applied to each of these filters throughout the year. Filters Nos. 421 to 426, inclusive, were filled from the top, the sewage being run directly onto the surface of the filters at such rates that the filter should be completely filled in about two minutes. Filter No. 427 was filled at the same rate, the sewage entering at the bottom of the filter and rising gradually through the material, thus displacing the air. Filter No. 428 was filled by means of a tipping basin discharging into a perforated pan placed 1 foot above the surface, by which the sewage was well aerated and entered the filter in small well-distributed doses, the rate of application being so regulated that one hour was required to fill the filter. Filters Nos. 424 to 428, inclusive, were each allowed to stand full one hour before draining, Filter No. 423 was allowed to stand full two hours, and Filters Nos. 422 and 421 were allowed to stand full four hours and eight hours, respectively, before draining. With the exception of Filter No. 425, which was filled twice daily, and Filter No. 426, which was filled three times daily, each of these filters was filled only once daily. In this series of eight filters, all identical as to size, depth and material and all operated with the same sewage, we have three separate comparisons of methods of operation. In Filters Nos. 421 to 424, inclusive, we have a comparison of the effect of contact periods of one, two, four and eight hours on filters operated one cycle daily. In filters Nos. 424, 425 and 426 we have a comparison of the effect of operating filters having a contact period of one hour, one, two and three complete cycles daily. In Filters Nos. 424, 427 and 428 we have a comparison as to the effect of filling filters, otherwise operated in the same manner, (*a*) by the usual method rapidly from the surface, (*b*) by a distributing and aerating device slowly from the surface, and (*c*) rapidly from the bottom. The method of operating each of these filters is shown in the following table: —

Filter No.	Method of Filling.	Contact Period (Hours).	Number of Cycles Daily.
421	Rapidly from surface, ...	8	1
422	Rapidly from surface, ...	4	1
423	Rapidly from surface, ...	2	1
424	Rapidly from surface, ...	1	1
425	Rapidly from surface, ...	1	2
426	Rapidly from surface, ...	1	3
427	Rapidly from bottom, ...	1	1
428	Slowly from surface, with distributor 12 inches above surface, .	1	1

The difference as to reduction in open space in these filters during the ten and one-half months they have been in operation has not been large. Of the four filters having different contact periods, No. 424, with a contact of one hour, lost 13 per cent. of open space; No. 423, with a two-hour contact, lost 15 per cent.; Filter No. 422, with a four-hour contact, lost 15 per cent. and No. 421, with an eight-hour contact, lost 17 per cent. of open space during the year. Of the three filters filled once, twice and three times daily, respectively, Filters Nos. 424 and 425, which were filled once and twice daily, respectively, each lost 13 per cent. of open space, and Filter No. 426, which was filled three times daily, lost 20 per cent. of open space during the year. Of the three filters to which the sewage was applied in different ways, Filters Nos. 424 and 428, which were each filled from the surface, but to which the sewage was applied differently, each lost about 16 per cent. of open space, while Filter No. 427, which was filled from the bottom, lost only about 10 per cent. of its capacity during the year. These various differences, while interesting, are relatively small, and should not be given too much importance at the present time when the filters have been operated only for a short time. The effluents produced by these various contact filters have varied considerably in composition, although none of them has been highly nitrified or entirely stable as has been the case with the effluents from some of the better contact filters operated at the station in previous years. In the case of the four filters operated with different contact periods the amount of nitrates in the effluents has varied inversely with the time the sewage remained within the filter, the average amount of nitrates in the effluent from Filter No. 424, in which only one hour's contact was given, being more than double that in the effluent from Filter No. 421 in which eight hours' contact was given. The amount of unoxidized nitrogen as free and albuminoid ammonia, however, was smallest in the effluents from the filter operated with the longest contact period, and greatest in that having the shortest period, and in general, the actual amount of purification accomplished, that is to say, the reduction of nitrogenous matters, increased with the time of contact. In the three filters operated to compare the effect of filling once, twice and three times daily, the amount of albuminoid ammonia was practically the same in the effluent from each. The amounts of free ammonia and of nitrates, however, were less in the effluent from the filter filled three times daily than in that from the filter filled only once daily. In the three filters operated to study the effect of methods of applying sewage, the effluent from the filter filled from the bottom was highest in free and albuminoid ammonia and lowest in nitrates, and the effluent from the filter which received its sewage by means of the distributing and aerating device was lowest in free and albuminoid ammonia and highest in nitrates.

The average analyses of the settled sewage applied to these filters are given on page 282. The average analyses of the effluents from these filters are shown in the following table: —

Effluent from Filter No. 175.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	Appearance.		Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Nitrogen as		Oxygen consumed.	Bacteria per Cubic Centimeter.
				Albuminoid.							
	Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.		
318,800	3.2	-	0.8379	.1312	.1063	.2637	12.73	.26	.0019	1.23	183,800

Effluent from Filter No. 421.

383,800	4.0	.59	1.9890	.2245	.1791	.4678	13.02	.10	.0004	1.62	888,000

Effluent from Filter No. 422.

376,500	4.2	.60	1.9612	.2478	.1791	.4821	13.09	.14	.0026	1.70	811,000

Effluent from Filter No. 423.

391,000	4.2	.61	2.1715	.2552	.1965	.5412	13.19	.18	.0064	1.85	1,177,000

Effluent from Filter No. 424.

388,400	4.2	.61	2.4325	.2704	.2160	.5786	13.29	.21	.0268	1.99	926,800

Effluent from Filter No. 425.

671,800	4.3	.61	2.2223	.2806	.2206	.6009	13.26	.14	.0084	2.09	1,052,300

Effluent from Filter No. 426.

894,800	4.1	.60	2.1493	.2708	.2115	.5895	13.16	.17	.0085	2.04	1,159,000

Effluent from Filter No. 427.

396,400	4.2	.61	2.4868	.2786	.2282	.5870	13.18	.07	.0188	2.17	1,097,700

Effluent from Filter No. 428.

387,300	4.2	.59	1.9951	.2413	.1907	.5260	13.33	.32	.0219	1.83	808,900

REMOVAL OF BACTERIA BY SEWAGE PURIFICATION SYSTEMS.

In the following table are shown the average numbers of bacteria as determined on agar plates incubated four days at 20° C., and of the total and red colonies on litmus lactose agar plates incubated eighteen hours at 40° C. The significance of these different counts has been discussed frequently in preceding reports. These results have been given annually during the past few years as being of sufficient interest to warrant their publication, and as a matter of record. During the past year the publication of the results of bacterial examinations of sewages and effluents from sewage filters has been attacked in an article in which the author attempted to show that as such results fluctuate considerably from time to time they have no value whatever in the control of the operation of sewage filters. That the numbers of bacteria in applied sewages and effluents from sewage filters and clarification treatments fluctuate from day to day and from hour to hour, and that similar fluctuations occur in the chemical results, has been known almost since the beginning of the scientific study of sewage disposal, and tables of results showing such fluctuations, and discussions of the same, have been published from time to time in the reports of the investigations at the Lawrence Experiment Station during the past twenty-five years. That the bacterial results have little value in the operating control of sewage disposal plants is also true in a great measure. The bacterial results, however, especially when given as averages of a large number of determinations, indicate what may or may not be expected of sewage purification systems of different types, and as such have not only a scientific value, but are of very practical value when we consider that the ultimate disposal of the purified or partially purified sewage is almost without exception by dilution, and that aside from the question of the production of a nuisance, which is usually paramount in sewage disposal, the question of how the public health may be affected by such disposal must usually be decided by bacterial examinations.

Of the three different methods of preliminary clarification of sewage studied, chemical precipitation was most efficient in removing the bacteria with a removal of about 69 per cent. of all types and 78 per cent. of the types growing at body temperature. The strainer of bituminous coal, as in previous years, was more effective in removing bacteria than was plain sedimentation in open tanks, but was somewhat less efficient than the process of contact sedimentation as carried out in the tank filled with layers of slate. As usual the removal of bacteria in the Andover settling tank was greater than that in the tank at the station. This, as has been explained in previous reports, may be attributed to the more finely divided state of the organic matters in the sewage entering the tank at the station.

All of the intermittent sand filters, situated out-of-doors, and operated with untreated sewage, show a bacterial removal of over 99 per cent. As in previous years, the effluents from Filters Nos. 2 and 4, constructed of fine sand and operated at low rates, have contained very small numbers of bacteria at times, so low, in fact, that they compared well in bacterial content with the effluents from water filters. At other times, however, the numbers have been too high to permit even these best sewage effluents to be classed with potable waters. The effluents from the sand filters operated with clarified sewage have also been of low bacterial content since these filters commenced to nitrify. The effluents from the filter receiving chemically precipitated sewage, however, have not been of as good quality bacterially as the effluents from the filters receiving settled and strained sewage, respectively.

The removal of bacteria by the deeper trickling filters, Nos. 135 and 136, has been superior to that of Filter No. 248, which is constructed of the same material but is of much less depth. The removal of over 91 per cent. of the bacteria by Filter No. 222, which is located at Andover, is a very satisfactory result, and the improvement over previous years may be attributed to the more complete nitrification which has followed the more perfect distribution of sewage upon this filter during the past three years. Analyses have been made of the effluents from different sections of trickling Filter No. 360 during the year, and while the results from the different sections have fluctuated from time to time, it is to be noted that the average result is very nearly the same for each section.

The bacterial efficiency of contact Filter No. 175 has been far better than that of the other contact filters operated during the year. This is undoubtedly to be attributed to the fact that this filter is older, and the purification processes have become more completely established than in the case of the other filters, which at this writing have not yet finished their first year of operation. Of these other contact filters there are no strongly marked differences in the bacterial results which may be attributed to the very different manner in which these filters have been operated. It is worthy of note, however, that the effluent from Filter No. 428, to which the sewage was applied by an aerating and distributing device, was of slightly better bacterial quality than the effluents from the other contact filters of the same series.

Table showing Removal of 20° and 40° C. Bacteria by Sewage Filters.

	Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.		
	20° C.	40° C.		20° C.	40° C.	
		Total.	Red.		Total.	Red.
Lawrence street sewage,	2,033,100	360,500	309,800	-	-	-
Regular sewage,	2,006,700	347,800	312,400	-	-	-
Andover regular sewage,	4,825,000	654,100	603,100	-	-	-
Settled sewage,	1,678,500	185,000	166,900	16.50	46.80	46.50
Andover settled sewage,	2,815,600	389,700	339,100	41.60	40.30	43.70
Effluent, slate tank No. 376,	992,500	231,400	196,900	50.70	33.50	36.90
Chemically precipitated sewage,	626,500	76,900	70,300	68.80	78.00	77.50
Effluent, Strainer E,	1,068,000	162,800	140,600	46.80	53.20	54.80
Effluent, sand filter: —						
No. 1,	10,500	2,700	2,350	99.48	99.22	99.25
2,	1,800	19	15	99.91	99.99	99.99
4,	820	13	11	99.96	99.99	99.99
5C,	12,800	3,800	3,400	99.36	98.91	98.91
6,	17,000	3,500	3,200	99.15	99.00	98.98
9A,	2,500	230	170	99.88	99.93	99.95
10,	5,300	430	320	99.74	99.88	99.90
429,	1,325	5	1	99.93	99.99	99.99
430,	1,220	96	82	99.93	99.95	99.95
431,	1,285	64	57	99.88	99.96	99.96
432,	8,430	34	26	98.66	99.96	99.96
Effluent, trickling filter: —						
No. 135,	37,800	3,280	2,890	97.75	98.23	98.27
136,	120,600	24,900	15,000	92.75	86.55	91.00
223,	250,900	18,400	15,600	91.10	95.28	95.42
248,	323,600	33,200	29,700	80.70	82.10	82.25
360A,	496,800	46,300	42,900	70.40	75.00	74.40
360B,	474,500	44,400	39,900	71.80	76.00	76.10
360C,	431,800	31,100	25,600	74.30	83.20	84.70
360 (entire),	329,400	29,900	26,700	80.40	83.85	84.00
Effluent, contact filter: —						
No. 175,	183,800	25,400	23,500	82.80	84.80	83.40
421,	888,000	78,800	68,000	47.20	57.50	59.30
422,	811,000	104,400	84,900	51.80	43.70	49.30
423,	1,177,000	323,200	297,500	29.70	74.60[1]	78.50[1]

[1] Increase.

Table showing Removal of 20° and 40° C. Bacteria by Sewage Filters — Concluded.

	Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.		
	20° C.	40° C.		20° C.	40° C.	
		Total.	Red.		Total.	Red.
Effluent, contact filter — *Con.*						
No. 424,	926,800	83,100	66,100	44.90	55.10	60.40
425,	1,052,300	104,300	84,900	37.50	43.70	49.20
426,	1,159,000	107,300	89,700	31.00	42.20	46.40
427,	1,097,700	112,500	94,500	34.50	38.90	43.50
428,	808,900	91,500	75,200	52.00	50.60	55.00

EXPERIMENTS UPON THE PURIFICATION OF THE WASTE LIQUORS FROM A RUBBER MILL.

During the latter part of 1910 and throughout the present year studies upon the purification of the waste liquors from a rubber mill have been in progress. The character and appearance of these wastes have varied widely, depending on the stock being worked and the part of the process from which they were collected. They have been generally nonputrescible, highly carbonaceous and have contained a large amount of suspended matters which settled readily. The wastes from the different processes have been mixed in proportion to the volume in which they flowed from the mill before treatment. This mixed waste, after settling, was applied to Filter No. 401, containing 3.5 feet in depth of sand of an effective size of 0.25 millimeter, at a rate of 25,000 gallons per acre daily. On April 7, 1911, the rate was increased to 50,000 gallons. It was found in the majority of cases that if this waste was slightly acidified a more or less voluminous precipitate would be formed. Portions of the waste were therefore acidified with sulphuric acid and settled, and the supernatant liquor, after being again made slightly alkaline, was applied to Filter No. 402. This filter, which was similar in construction to Filter No. 401, was put into operation on Nov. 10, 1910. Until December 19 the precipitated waste was applied to this filter at a rate of 25,000 gallons per acre daily, when the rate was increased to 50,000 gallons per acre daily. On Feb. 2, 1911, the rate was again decreased to 25,000 gallons per acre daily, at which rate the filter was operated until April 7, when the 50,000-gallon rate was again resumed. The average rates for the whole period of operation were 30,000 and 36,000 gallons per acre daily for Filters Nos. 401 and 402, respectively. The effluents from both of these filters were more or less turbid and somewhat colored, depending on the character of the waste applied, and there was very little nitrification.

These experiments seem to show that it is possible to get fair clarification of these wastes by settling, followed by sand filtration at rates of 25,000 to 50,000 gallons per acre daily. By the addition of about 1,500 pounds of sulphuric acid per million gallons of waste, a considerable portion of the carbonaceous matter can be coagulated and settled out and a much higher rate can be used.

Average analyses of the raw and treated wastes, and of the effluents from these two filters, are shown in the following tables: —

Average Analyses.

Raw Waste from a Rubber Mill.

[Parts per 100,000.]

PERIOD.	Color.	AMMONIA.			KJELDAHL NITROGEN.		NITROGEN AS		Oxygen consumed.	Hardness.
			ALBUMINOID.							
		Free.	Total.	In Solution.	Total.	In Solution.	Nitrates.	Nitrites.		
September, 1910–May, 1911, inclusive.	-	1.01	2.96	0.94	5.88	1.84	-	-	69.0	40.4

Waste applied to Filter No. 401.

PERIOD.	Color.	Free.	Total.	In Solution.	Total.	In Solution.	Nitrates.	Nitrites.	Oxygen consumed.	Hardness.
September, 1910–May, 1911, inclusive.	-	0.74	1.43	-	-	-	-	-	35.5	-

Waste applied to Filter No. 402.

PERIOD.	Color.	Free.	Total.	In Solution.	Total.	In Solution.	Nitrates.	Nitrites.	Oxygen consumed.	Hardness.
November, 1910–May, 1911, inclusive.	-	0.67	0.91	-	-	-	-	-	18.3	-

Effluent from Filter No. 401.

PERIOD.	Color.	Free.	Total.	In Solution.	Total.	In Solution.	Nitrates.	Nitrites.	Oxygen consumed.	Hardness.
September, 1910–June, 1911, inclusive.	1.05	.0935	.1600	-	-	-	.06	.0013	12.03	41.7

Effluent from Filter No. 402.

PERIOD.	Color.	Free.	Total.	In Solution.	Total.	In Solution.	Nitrates.	Nitrites.	Oxygen consumed.	Hardness.
November, 1910–June, 1911, inclusive.	0.43	.1144	.0967	-	-	-	.05	.0016	4.18	43.5

Average Solids.

Raw Waste from a Rubber Mill.

[Parts per 100,000.]

PERIOD.	UNFILTERED.			FILTERED.		
	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
September, 1910–May, 1911, inclusive,	1158.9	939.8	219.1	321.1	238.2	82.9
Waste applied to Filter No. 401.						
November, 1910–May, 1911, inclusive,	177.0	117.5	59.5	-	-	-

Average Bacterial Results.

Effluent from Filter No. 401.

PERIOD.	BACTERIA PER CUBIC CENTIMETER.		
	20° C.	40° C.	
		Total.	Red.
December, 1910–April, 1911, inclusive,	428,100	1,007	271
Effluent from Filter No. 402.			
December, 1910–April, 1911, inclusive,	327,800	213	104

Table showing Per Cent. Reduction.

	SOLIDS.			AMMONIA.		Oxygen consumed.
	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	
Settling,	77.4	79.8	69.8	37.4	49.0	52.2
Acidification and settling,	-	-	-	26.4	64.9	62.6
Filter No. 401,	-	-	-	86.2	90.5	77.5
Filter No. 402,	-	-	-	83.0	89.4	77.1

THE INFLUENCE OF CARBON UPON NITRIFICATION, ESPECIALLY IN MILL WASTE PURIFICATION.

During the past twenty-three years many experiments have been made at the Lawrence Experiment Station of the Massachusetts State Board of Health to determine the effect upon nitrification of an excess of a number of substances which may occur naturally in sewage or may at times find their way into it. The substances previously studied — the results in regard to which have been given in the various reports of the station, and especially in that of 1908 — have been albumen, peptone, ammonium chloride and sodium carbonate, sulphuric acid, saltpeter, common salt, sugar, soap, urine, free oxygen, phenol, mercuric chloride, formalin, arsenic, naphthalene, sulphides, bleaching powder and copper sulphate. As stated in the conclusions of the summary of this work in the report of the station for 1908, "the experiments illustrate the adaptability of the nitrifying body to the conditions imposed, and establish another fundamental law of sewage purification, that if nitrification is to continue in the presence of an excess of any substance, the filter must become slowly accustomed to the presence of that substance by application of it in gradually increasing amounts; that when once accustomed to considerable amounts of any substance the process of nitrification will proceed unimpaired." It of course follows, however, that a great excess of any substance inimical to nitrification will prevent nitrification.

In the various investigations necessitated by the work of the State Board of Health, many experiments have been carried on in regard to the purification of mill wastes by filtration, many of these wastes containing very much more carbonaceous than nitrogenous matter. It appeared from this work that at times with many of these wastes, and at all times with some of them, good purification and a satisfactory effluent could be obtained when nitrates were not found in the effluents of the filters operated, even although the wastes themselves contained much nitrogen. Studies of this phenomenon appeared to show that whether nitrification occurred or not depended upon the relation of the amount of carbonaceous to nitrogenous matter present in the liquid or waste undergoing treatment; that is to say, nitrification could apparently proceed when the amount of nitrogen was represented by x and carbon by 10x, but would be eliminated when the carbon was increased to 12 or 15x. In order to make a thorough investigation of this subject certain small experimental filters were put into operation early in the year 1910, and the work has continued until the present time. The method has been to apply to the sand filters used, Lawrence sewage freed from matter in suspension to which has been added some body rich in carbon. Practically all the carbon and nitrogen applied has been in solution, and by this means surface clogging and storage of organic matter in the filters have been prevented.

The bodies added to the different filters with the sewage have been sugar, molasses, butyric acid, alcohol and filtered wool-scouring waste, and these filters have been operated generally at a rate of 50,000 gallons per acre daily. Careful and frequent determinations of the relation between the carbon and the nitrogen in the liquid applied have been made and also frequent analyses of the effluent from each filter. The carbon values were calculated in the case of sugar, alcohol and butyric acid, the composition of which was known, and in the case of molasses the approximate composition of which could be calculated. The carbon content of the sewage used and of the filtered wool-scourings were calculated from data obtained from other experiments upon the relation between loss on ignition and carbon.[1] While it is not feasible to present here the full data in regard to this investigation, the data in regard to the operation of several filters are given beyond to show the general method followed and the results obtained. In all, twenty filters have been operated.

In the operation of these filters the carbon-containing bodies have generally been added in slowly increasing amounts, while the nitrogen applied has been kept constant. During the period when the ratio of carbon to nitrogen has remained low, active nitrification has occurred in each filter and high nitrates have been present in their effluents. When nitrification has been checked by the large amounts of carbon applied, each filter has been continued in operation long enough to prove conclusively that nitrification would not again become active until the ratio of carbon to nitrogen was considerably reduced, and also long enough to prove that good purification continued without nitrifying conditions in the filter. In all instances several duplicate experiments with the same carbonaceous substance were made in order to prevent errors in the work and conclusions. Experiments were also made showing that when nitrification had been checked, but not entirely stopped by the carbon, it would be re-established by increasing the amount of nitrogen in the liquid applied and keeping the carbon constant, this of course reducing the ratio of carbon to nitrogen. It was also found that when ammonium chloride was added to the sewage, nitrification was not checked by carbonaceous bodies even when added in very large amounts.

The main results of these experiments can be summarized as follows: —

When sugar was added in such amounts that the applied liquid contained less than 50 parts of carbon, nitrification was stopped in three separate experiments when the average carbon to nitrogen ratio was 13, 14 and 15. When the ratio was 11.6, 11.1 and 11.0, nitrification was not seriously checked. When nitrogen as NH_4Cl was added, nitrification took place even when 200 parts of carbon as sugar was present in the applied liquid, the ratio of carbon to nitrogen being 10.8. When molasses was added with the sewage, nitrification was stopped when the average carbon to nitrogen ratio was above 12, but was active when this ratio was 10 and 11. With butyric acid, nitrification was not seriously impaired when the average carbon to nitrogen ratio varied between 13 and 16, but was prevented when the carbon to nitrogen ratio was 27. When nitrogen as NH_4Cl was added with the butyric acid, nitrification took place even when acid equivalent to 200 parts carbon was present, the ratio of carbon to nitrogen being 14.0. With alcohol, nitrification was active when the average carbon to nitrogen ratio was 13 and 13.8, but was stopped when the average ratio was 15 and 16. When nitrogen as NH_4Cl was added with the alcohol, 400 parts of alcohol equal to 160 parts carbon could be applied to the filter and nitrification remain active, the carbon to nitrogen ratio under these conditions being 12.2. With filtered wool-scouring waste .diluted with water, nitrification continued as long as the carbon to nitrogen ratio was below 14, the carbon running up to 350 parts per 100,000, but was stopped when the carbon to nitrogen ratio was increased to 17 by the addition of sugar.

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[1] Journal of Industrial and Engineering Chemistry, Vol. 3, No. 10, p. 738.

Data in regard to three of these filters follow, and it will be noticed that even when nitrification ceased and the filters continued in operation, the amount of free and albuminoid ammonia present in the effluents from these filters was not much greater than when nitrification was active. This occurred although the same amount of nitrogenous matter was being applied as when nitrification was active.

As stated in the beginning, these results are similar to those obtained frequently with mill wastes and occasionally with domestic sewage, and show that purification can take place in certain filters under the conditions imposed by the addition of large amounts of carbonaceous matter even although nitrification in the filter ceases. This purification without nitrification is, we presume, due to certain bacteria which are active under conditions which prevent nitrification but cause chemical actions which break down organic matter and result in the setting free of carbonic acid gas and nitrogen. It is distinctly different from the action sometimes occurring in contact filters where the nitrates formed do not appear in the effluent, as in such filters further oxidation of organic matter is accomplished within the filter by the use of the oxygen of these nitrates and their consequent reduction.

The intense activity of the filter in changing carbonaceous matter to the gaseous form, and the liberation and disappearance of carbon in this way, is strikingly shown by the "oxygen-consumed" results of the applied liquid and effluent. These results show the great decrease of required oxygen, and this decrease was not caused by storage of carbonaceous matter, as this matter was applied in solution. The loss of nitrogen by liberation can be seen by the figures showing the percentage of that applied appearing in each effluent during different periods of operation of each filter, these results showing a steadily decreasing percentage of applied nitrogen appearing in the effluent from each filter operated.

Filter receiving Sewage to which Molasses was added. Analyses at Intervals.

[Parts per 100,000.]

Free ammonia: —					
Applied liquid,	4.3000	2.2800	3.0300	2.2500	2.4000
Effluent from filter,	0.1880	0.1400	0.1500	0.2700	0.2700
Albuminoid ammonia: —					
Applied liquid,	0.3300	0.3100	0.3900	0.3900	0.4200
Effluent from filter,	0.0260	0.0360	0.0400	0.0420	0.0460
Oxygen consumed: —					
Applied liquid,	12.1400	16.9900	19.1000	23.8000	23.8000
Effluent from filter,	0.2200	0.2600	0.3500	0.3100	0.3900
Kjeldahl nitrogen: —					
Applied liquid,	0.6700	0.7600	0.7600	0.8500	0.8400
Nitrogen as nitrites: —					
Effluent from filter,	0.0016	0.0014	0.0012	0.0004	0.0002
Nitrogen as nitrates: —					
Effluent from filter,	2.5200	2.1800	2.0100	0.8400	0.1000
Total carbon: —					
Applied liquid,	34.8000	50.4000	55.5000	68.5000	68.5000
Ratio C/N: —					
Applied liquid,	8.3000	16.1000	17.0000	24.4000	24.3000
Per cent. applied nitrogen in effluent,	65.0	75.0	68.0	39.0	15.0

Filter receiving Sewage to which Butyric Acid was added. Analyses at Intervals.

[Parts per 100,000.]

Free ammonia: —							
Applied liquid,	3.0300	3.0300	2.7000	2.9800	2.9800	2.9800	2.9800
Effluent from filter,	0.2200	0.1200	0.1800	0.0880	0.1700	0.1480	0.1300
Albuminoid ammonia: —							
Applied liquid,	0.2500	0.2500	0.2000	0.2500	0.2700	0.2700	0.2700
Effluent from filter,	0.0280	0.0200	0.0140	0.0360	0.0360	0.0380	0.0440
Oxygen consumed: —							
Applied liquid,	2.6900	2.6900	2.0000	2.0000	2.0000	2.0000	2.0000
Effluent from filter,	0.2100	0.2300	0.2200	0.2600	0.1800	0.2200	0.2100
Kjeldahl nitrogen: —							
Applied liquid,	0.6400	0.6400	0.5000	0.6400	0.6500	0.6500	0.6500
Nitrogen as nitrites: —							
Effluent from filter,	0.0040	0.0020	0.0012	0.0006	0.0006	0.0006	0.0006
Nitrogen as nitrates: —							
Effluent from filter,	0.7500	0.6300	1.0100	2.4000	0.3400	0.0500	0.0500
Total carbon: —							
Applied liquid,	37.6000	37.6000	37.6000	54.0000	84.7000	84.7000	84.7000
Ratio C/N: —							
Applied liquid,	12.0000	12.0000	13.8000	17.5000	27.4000	27.4000	27.4000
Per cent. applied nitrogen in effluent,	32.0	25.0	44.0	82.0	18.0	8.0	8.0

Filter receiving Sewage to which Sugar was added. Analyses at Intervals.

[Parts per 100,000.]

Free ammonia: —							
Applied liquid,	3.3000	3.8200	3.8400	2.8800	3.0300	2.2500	2.4000
Effluent from filter,	0.0200	0.0220	0.0240	0.0180	0.0340	0.0500	0.1400
Albuminoid ammonia: —							
Applied liquid,	0.2500	0.2400	0.2700	0.2100	0.1900	0.1900	0.1700
Effluent from filter,	0.0200	0.0120	0.0160	0.0260	0.0200	0.0220	0.0220
Oxygen consumed: —							
Applied liquid,	1.6000	14.2200	13.4000	13.5000	15.5000	13.9000	14.0000
Effluent from filter,	0.1300	0.1200	0.1800	0.1600	0.1800	0.1400	0.1500
Kjeldahl nitrogen: —							
Applied liquid,	0.4700	0.5600	0.4500	0.7600	0.3600	0.4500	0.3400
Nitrogen as nitrites: —							
Effluent from filter,	0.0040	0.0012	0.0004	0.0004	0.0004	0.0002	0.0002
Nitrogen as nitrates: —							
Effluent from filter,	3.1100	1.3900	2.6500	2.8600	1.4300	0.6700	0.0400
Total carbon: —							
Applied liquid,	4.7000	40.7000	39.2000	41.6000	45.5000	46.0000	43.3000
Ratio C/N: —							
Applied liquid,	1.5000	11.0000	10.9000	14.7000	15.9000	20.0000	18.4000
Per cent. applied nitrogen in effluent,	99.1	38.5	74.7	104.0	52.0	33.0	9.0

The following table shows the average results obtained during the past fifteen years of a number of filters operated with various mill wastes. The effluents from all these filters have been stable and usually clear and odorless. It will be noticed that where the ratio of carbon to nitrogen in the waste applied to the filter is around 10, there has been nitrification. In the case of the carpet mill waste the first filter gave no nitrification because the carbon to nitrogen ratio was 16. This filter reduced the carbon to nitrogen ratio of the liquid to 9.0 so that when the effluent from the first was applied to a second filter, nitrification took place in the secondary filter.

KIND OF WASTE.	APPLIED WASTE (PARTS PER 100,000).			EFFLUENT (PARTS PER 100,000).	
	Total Nitrogen.	Approximate Amount of Carbon.	Ratio C/N.	Albuminoid Ammonia.	Nitrogen as Nitrates.
Dyeing cotton,	0.58	41.6	71	.0891	0.02
Washing and dyeing cotton,	0.76	21.8	29	.0514	0.01
Dyeing and finishing,	0.57	11.4	20	.2960	0.00
Dyeing and finishing,	0.27	5.2	19	.0950	0.07
Cotton batting,	1.25	21.9	18	.0614	0.04
Carpet mill,	2.24	3.6	16	.4789	0.05
Dyeing and finishing,	1.80	26.8	15	.1465	0.10
Scouring and dyeing,	0.91	10.8	12	.0703	0.37
Effluent from Filter No. 2, carpet mill,	0.93	8.5	9	.1568	0.32
Binder's board,	0.49	4.0	8	.0355	0.11
Shoddy mill,	0.77	4.0	5	.0534	1.01
Tannery,	4.65	19.4	4	.0374	3.63

PURIFICATION OF WATER.

During 1911 studies have been continued upon the purification of Merrimack River water by slow sand filtration, by double filtration and by mechanical filters with the aid of coagulants; upon the preliminary clarification of water by upward filtration through a roughing filter of coarse gravel; and upon the purification of water by a sand filter to which the water is applied at frequent intervals in small doses, in much the same way, in fact, that sewage is applied to sprinkling or trickling filters. As in previous years, special attention has been paid to the work of the filters which purify the water supply of the city of Lawrence. During the year a new series of experiments has been started to study the relative efficiency of continuous water filters of the same depth and size of material when operated at widely different rates.

LAWRENCE CITY FILTERS.

The source of the water supply of the city of Lawrence is the Merrimack River. Two filters are in use to purify this water. The older filter was constructed in 1893, and dividing walls separating it into three sections were built in 1902. The average depth of sand in this filter is about 4 feet and the net filtering area, after deducting division walls, gate-chambers and lateral carriers, is about 2.2 acres. As originally constructed, this filter contained two different grades of sand, the portions of the filter immediately over the underdrains being of finer sand than the remainder of the filter. Through the operations of scraping, washing and replacing sand, the two grades of sand have become quite thoroughly mixed in the upper layers of the filter, and at the present time this upper sand has an effective size of approximately 0.25 millimeter. This filter is not covered and has an earth bottom through which some ground water finds its way into the underdrains and becomes mixed with the filtered water. The average rate of operation during the past few years has been about 1,000,000 gallons per acre daily.

During 1906 and 1907 an additional filter was constructed to supplement the supply of filtered water from the old filter. This filter, which is three-quarters of an acre in area and contains about 4½ feet in depth of sand of an effective size of 0.25 millimeter, is of concrete construction, has a concrete bottom and is covered. It was first put into operation on Nov. 4, 1907, but the filtered water was not used until Jan. 4, 1908. The rate of operation during the year has been about 3,000,000 gallons per acre daily. The effluents from both filters flow into the same pump-well from which they are pumped into the distributing reservoir. Neither of these two filters is equipped with a rate-regulating device, but careful observations and estimates show that approximately 45 per cent. of all the water used during the year was obtained from the new covered filter. During certain portions of the year, moreover, owing to the accumulation of ice upon the old uncovered filter, this filter was not scraped as often as it should have been, and a large proportion of the water was at these times furnished by the new covered filter. Scraping records of the two filters show that the covered filter was scraped three times during January and February, while the uncovered filter was scraped but once during these months.

During 1911 the rainfall was smaller and the flow of the river less than in any other year since the Lawrence filter was put into operation. Owing to the scarcity of water it has been held back at the dams of the various power companies on the river, and when applied to the filter it has been more polluted and has contained a smaller amount of dissolved oxygen than in previous years. The water, therefore, has been much more difficult to purify, and the efficiency of the filters during the year has been seriously tested. That they have been efficient bacterially is shown by the results of the analyses made at frequent intervals, and by the extremely small number of cases of typhoid fever in the city during the year. The average numbers of bacteria in the effluents from these two filters were 46 per cubic centimeter for the old filter and 83 per cubic centimeter for the new filter, both of these averages being lower than the corresponding averages during any preceding year since the new filter was put into operation. In only a very few instances were the numbers of bacteria in samples of the effluents from either of these filters found to be more than 100 per cubic centimeter. The average removal of bacteria by the old filter was 99.6 per cent. and by the new filter 99.2 per cent.

The special significance of the numbers of bacteria growing at body temperature has been pointed out a number of times in previous reports. The average numbers of bacteria of these types were 10 per cubic centimeter in the effluent from the old filter and 17 per cubic centimeter in the effluent from the new filter, the average removal of these bacteria by these two filters being about 94 and 90 per cent., respectively. In addition to the tests for the presence of B. coli in volumes of 1 and 100 cubic centimeters — which tests have been made regularly on samples from these sources for a number of years — tests were also made during the past year for the occurrence of this type of bacteria in all samples in volumes of 10 cubic centimeters. The test organisms were isolated from the effluent from the old filter in about 5 per cent. of the 1 cubic centimeter tests, in about 41 per cent. of the 10 cubic centimeter tests, and in about 71 per cent. of the 100 cubic centimeter tests; and from the effluent from the new filter in about 27 per cent. of the 1 cubic centimeter tests, in about 62 per cent. of the 10 cubic centimeter tests, and in about 85 per cent. of the 100 cubic centimeter tests. That the effluent from the old filter was superior in quality to that from the new filter, bacterially, is quite evident from these results, but this fact is not surprising when the difference in the rates at which these two filters were operated is taken into consideration.

The total number of cases of typhoid fever in the city during the calendar year 1911 was 37, the smallest number since the filtration of the public water supply was begun in 1893. Of these 37 cases, moreover, 8 were of persons who were proved to have contracted the disease while away from the city, and 8 more were of persons employed in the mills where the unpurified canal water is used freely for manufacturing purposes. These patients, therefore, may have drunk, and in some cases undoubtedly did drink, this water to a greater or less extent. The total number of deaths from typhoid was 9, of which 2 were of persons who contracted the disease while away from the city, and 1 may have drank canal water. The total number of deaths from this disease in Lawrence was the lowest since 1904, when the same number was recorded, but in these seven years the population of the city has increased from less than 70,000 to about 89,000 persons.

Owing to the small amount of dissolved oxygen in the river water there were periods during the months of August and September when this oxygen was exhausted in oxidizing the organic matter in the water while it was passing at a comparatively high rate through the new filter, hence iron oxides in the sand were reduced and much iron appeared in solution in the effluent from this filter. The effect of storage of this filtered water in the reservoir having a capacity of 40,000,000 gallons is well shown by the fact that this increased iron did not appear at the reservoir outlet until October.

The yearly record of typhoid fever during the past ten years and the usual chemical and bacterial analyses are shown in the following tables: —

Record of Typhoid Fever in Lawrence for Last Ten Years.

YEAR.	Population.	TOTAL.		PERSONS WHO CONTRACTED THE DISEASE AWAY FROM THE CITY.		PERSONS WHO MAY HAVE CONTRACTED THE DISEASE BY THE USE OF CANAL WATER.		INCIDENCE, PER 100,000 POPULATION.	
		Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
1902	64,400[1]	103	11	6	2	37	4	160	17
1903	66,300[1]	151	22	7	1	73	6	228	33
1904	69,600[1]	60	9	3	1	15	1	86	13
1905	70,050[2]	98	14	10	1	23	2	140	20
1906	73,300[1]	106	15	5	.0	50	3	145	20
1907	76,616[3]	77	21	5	1	77	8	100	27
1908	79,700[1]	111	18	8	6	48	5	139	23
1909	82,800[1]	84	18	7	0	28	6	101	22
1910	85,892[4]	77	14	4	1	39	14	90	16
1911	88,984[1]	37	9	8	2	8	1	42	10

[1] Estimated. [2] State census. [3] Special census. [4] National census.

Average Chemical Analyses.

Merrimack River. — Intake of the Lawrence City Filters.

[Parts per 100,000.]

DATE.	Temperature (Degrees F.).	APPEARANCE.		AMMONIA.			Chlorine.	NITROGEN AS		Oxygen consumed.	Iron.	Hardness.	Soap Hardness.
					ALBUMINOID.								
		Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.				
1910.													
December, . .	33	0.3	.30	.0381	.0302	.0253	.73	.027	.0007	.78	.0750	1.9	-
1911.													
January, . .	-	0.3	.32	.0184	.0252	.0234	.44	.028	.0004	.73	.0470	1.2	-
February, . .	33	0.2	.26	.0311	.0268	.0233	.52	.023	.0006	.63	.0400	1.4	-
March, . . .	34	0.2	.33	.0226	.0270	.0225	.50	.021	.0004	.67	.0510	1.2	1.4
April, . . .	45	0.2	.41	.0067	.0194	.0158	.22	.010	.0002	.57	.0510	0.7	1.4
May, . . .	63	0.3	.40	.0172	.0248	.0207	.34	.011	.0008	.62	.0550	1.2	1.2
June, . . .	72	0.4	.26	.0262	.0289	.0202	.47	.015	.0007	.56	.0800	1.6	1.5
July, . . .	81	0.3	.25	.0351	.0334	.0283	.58	.010	.0009	.63	.0680	1.9	1.8
August, . .	76	0.3	.26	.0290	.0344	.0207	.70	.008	.0012	.67	.1000	1.9	2.0
September, . .	69	0.3	.22	.0252	.0265	.0217	.58	.009	.0009	.67	.0920	1.7	2.1
October, . .	54	0.2	.19	.0128	.0245	.0226	.40	.014	.0005	.74	.0750	1.3	2.0
November, . .	41	0.3	.23	.0156	.0237	.0224	.48	.015	.0002	.61	.0600	1.0	2.3
Average, .	55	0.3	.29	.0232	.0271	.0222	.50	.016	.0006	.66	.0662	1.4	1.7

Effluent from the Lawrence City Filter (Old Filter).

[Parts per 100,000.]

Date.	Temperature (Degrees F.).	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen consumed.	Iron.	Hardness.	Soap Hardness.
		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.				
1910.												
December,	36	0.1	.24	.0418	.0122	.75	.038	.0003	.52	.1030	2.3	-
1911.												
January,	-	0.1	.26	.0143	.0112	.47	.039	.0007	.47	.0950	1.6	-
February,	36	0.0	.20	.0176	.0100	.56	.042	.0002	.39	.1250	1.9	-
March,	36	0.0	.30	.0169	.0122	.54	.046	.0004	.44	.1600	1.8	2.2
April,	-	0.1	.35	.0158	.0105	.31	.037	.0006	.43	.1430	1.7	2.3
May,	62	0.0	.28	.0159	.0099	.36	.036	.0002	.35	.1170	1.6	1.8
June,	71	0.0	.19	.0145	.0114	.48	.022	.0005	.37	.1350	2.1	2.1
July,	80	0.1	.27	.0235	.0172	.64	.013	.0001	.57	.1600	2.5	2.2
August,	75	0.0	.21	.0136	.0107	.69	.019	.0005	.41	.1330	2.4	2.5
September,	68	0.1	.23	.0136	.0112	.64	.019	.0006	.47	.1660	2.2	2.6
October,	54	0.1	.15	.0128	.0114	.52	.015	.0002	.44	.1700	1.9	3.1
November,	41	0.1	.22	.0158	.0127	.48	.038	.0002	.41	.1450	1.6	2.9
Average,	56	0.1	.24	.0180	.0117	.54	.030	.0004	.44	.1377	2.0	2.4

Effluent from the Lawrence City Filter (New Filter).

1910.												
December,	35	0.0	.23	.0430	.0124	.69	.030	.0001	.54	.0385	1.8	-
1911.												
January,	-	0.1	.25	.0104	.0130	.43	.059	.0003	.51	.0220	1.2	-
February,	35	0.0	.21	.0136	.0110	.52	.038	.0005	.42	.0225	1.4	-
March,	35	0.0	.26	.0084	.0142	.51	.036	.0003	.50	.0290	1.3	1.7
April,	-	0.0	.33	.0042	.0126	.23	.025	.0002	.42	.0160	0.8	1.5
May,	55	0.0	.31	.0042	.0112	.33	.043	.0001	.38	.0190	1.0	1.4
June,	70	0.0	.15	.0055	.0138	.48	.011	.0001	.42	.0210	1.6	1.9
July,	81	0.1	.15	.0249	.0168	.60	.009	.0001	.50	.0335	2.0	1.8
August,	75	0.0	.22	.0219	.0140	.66	.002	.0001	.49	.2510	2.3	2.5
September,	69	0.1	.20	.0104	.0094	.60	.013	.0005	.52	.1240	2.0	2.2
October,	54	0.0	.15	.0026	.0103	.50	.008	.0002	.43	.0400	1.5	2.8
November,	41	0.0	.19	.0030	.0155	.44	.024	.0001	.43	.0400	1.2	2.5
Average,	55	0.0	.22	.0127	.0128	.50	.025	.0002	.46	.0547	1.5	2.0

Water from the Outlet of the Distributing Reservoir.

[Parts per 100,000.]

DATE.	Temperature (Degrees F.).	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS		Oxygen consumed.	Iron.	Hardness.	Soap Hardness.
		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.				
1910. December, . .	36	0.0	.32	.0243	.0117	.68	.036	.0008	.47	.0900	2.0	-
1911. January, . .	-	0.1	.36	.0253	.0126	.62	.047	.0004	.46	.0950	2.0	-
February, . .	35	0.2	.33	.0143	.0097	.52	.043	.0001	.42	.0870	1.6	-
March, . . .	35	0.0	.33	.0132	.0103	.56	.046	.0002	.42	.0950	1.7	2.2
April, . . .	44	0.1	.41	.0078	.0110	.34	.025	.0002	.38	.0960	1.4	1.9
May, . . .	59	0.0	.37	.0053	.0117	.27	.032	.0002	.34	.0660	1.4	1.5
June, . . .	68	0.1	.20	.0054	.0107	.48	.017	.0004	.35	.0710	1.7	1.9
July, . . .	75	0.1	.27	.0105	.0158	.60	.012	.0005	.50	.0750	2.1	2.3
August, . .	74	0.2	.24	.0066	.0129	.71	.016	.0003	.36	.0750	2.2	2.3
September, . .	67	0.1	.21	.0033	.0097	.65	.022	.0006	.42	.0900	2.0	2.1
October, . .	55	0.2	.24	.0057	.0114	.57	.032	.0003	.45	.1450	1.6	3.2
November, . .	45	0.0	.28	.0052	.0132	.46	.035	.0000	.44	.1350	1.3	2.5
Average, .	54	0.1	.30	.0106	.0117	.54	.030	.0003	.42	.0933	1.8	2.2

Average Chemical Analyses.

Water from a Tap at Lawrence City Hall.

[Parts per 100,000.]

Temperature (Degrees F.).	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS		Oxygen consumed.	Iron.	Hardness.	Soap Hardness.
	Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.				
55	0.3	.39	.0088	.0129	.54	.033	.0003	.42	.1458	1.8	2.2

Water from a Tap at the Lawrence Experiment Station.

54	0.1	.31	.0071	.0118	.54	.034	.0002	.39	.0942	1.7	2.2

Solids.

Merrimack River. — Intake of Lawrence City Filters.

[Parts per 100,000.]

DATE.	UNFILTERED.			FILTERED.			IN SUSPENSION.		
	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
1910.									
December,	9.2	3.3	5.9	8.7	3.1	5.6	0.5	0.2	0.3
1911.									
January,	7.2	3.0	4.2	6.8	2.9	3.9	0.4	0.1	0.3
February,	6.5	2.5	4.0	6.3	2.5	3.8	0.2	0.0	0.2
March,	8.0	3.6	4.4	6.4	3.2	3.2	1.6	0.4	1.2
April,	8.0	3.6	4.4	6.4	3.2	3.2	1.6	0.4	1.2
May,	8.1	3.3	4.8	6.7	3.1	3.6	1.4	0.2	1.2
June,									
July,	9.4	3.5	5.9	8.4	3.0	5.4	1.0	0.5	0.5
August,									
September,	9.4	3.4	6.0	9.0	3.2	5.8	0.4	0.2	0.2
October,	7.2	2.7	4.5	6.7	2.5	4.2	0.5	0.2	0.3
November,	7.0	2.8	4.2	6.7	2.6	4.1	0.3	0.2	0.1
Average,	8.1	3.2	4.9	7.3	3.0	4.3	0.8	0.2	0.6

Solids.

[Parts per 100,000.]

DATE.	EFFLUENT FROM LAWRENCE CITY FILTER (OLD FILTER).			EFFLUENT FROM LAWRENCE CITY FILTER (NEW FILTER).		
	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
1910.						
December,	-	-	-	-	-	-
1911.						
January,	-	-	-	-	-	-
February,	-	-	-	-	-	-
March,	6.8	3.2	3.6	5.7	3.2	2.5
April,						
May,	6.4	2.6	3.8	6.3	2.7	3.6
June,						
July,	8.6	3.0	5.6	8.5	3.1	5.4
August,						
September,	9.3	2.8	6.5	8.5	2.7	5.8
October,	7.2	2.7	4.5	7.2	2.4	4.8
November,	6.7	2.3	4.4	5.7	1.9	3.8
Average,	7.4	2.8	4.6	6.9	2.8	4.1

Solids.

[Parts per 100,000.]

DATE.	WATER FROM THE OUTLET OF THE DISTRIBUTING RESERVOIR.			WATER FROM A TAP AT LAWRENCE CITY HALL.			WATER FROM A TAP AT THE LAWRENCE EXPERIMENT STATION.		
	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
1910.									
December,	-	-	-	-	-	-	-	-	-
1911.									
January,	-	-	-	-	-	-	-	-	-
February,	-	-	-	-	-	-	-	-	-
March,	6.9	2.8	4.1	7.4	2.6	4.8	7.2	2.2	5.0
April,									
May,	6.0	2.0	4.0	6.3	2.4	3.9	6.3	2.0	4.3
June,									
July,	8.5	2.8	5.7	8.5	3.3	5.2	9.6	3.1	6.5
August,									
September,	7.5	2.1	5.4	9.1	2.7	6.4	8.0	2.7	5.3
October,	7.1	2.6	4.5	7.7	2.8	4.9	6.9	2.5	4.4
November,	6.6	2.2	4.4	5.8	2.2	3.6	6.9	2.3	4.6
Average,	7.1	2.5	4.6	7.4	2.7	4.7	7.6	2.5	5.1

Average Bacterial Analyses.

Merrimack River. — Intake of the Lawrence City Filters.

DATE.	BACTERIA PER CUBIC CENTIMETER.		
	20° C.	40° C.	
		Total.	Red.
1910.			
December,	23,000	101	72
1911.			
January,	19,000	300	200
February,	14,200	200	160
March,	16,300	153	99
April,	6,600	85	70
May,	7,000	170	150
June,	9,800	283	234
July,	1,300	57	31
August,	2,500	89	62
September,	17,700	394	334
October,	7,300	116	95
November,	5,900	130	96
Average,	10,900	175	135

Average Bacterial Analyses.

Effluent from the Lawrence City Filter (Old Filter).

DATE.	BACTERIA PER CUBIC CENTIMETER.			PER CENT. OF BACTERIA REMOVED.			PER CENT. OF SAMPLES CONTAINING B. COLI.		
	20° C.	40° C. Total.	40° C. Red.	20° C.	40° C. Total.	40° C. Red.	1 c. c.	10 c. c.	100 c. c.
1910. December,	70	3	1	99.7	97.0	98.6	0.0	0.0	100.0
1911. January,	60	18	8	99.7	94.0	96.0	0.0	44.4	55.5
February,	50	19	11	99.6	90.5	93.1	0.0	62.5	50.0
March,	40	28	11	99.8	81.7	88.9	10.0	50.0	90.0
April,	22	7	2	99.7	91.8	97.1	0.0	0.0	42.8
May,	13	6	3	99.8	96.5	98.0	0.0	12.5	44.5
June,	11	2	1	99.9	99.3	99.6	12.5	14.3	75.0
July,	36	12	6	97.2	79.0	80.7	0.0	33.3	60.0
August,	14	5	1	99.4	94.4	98.5	14.3	71.5	100.0
September,	102	5	2	99.4	98.7	99.4	16.7	75.0	100.0
October,	17	4	1	99.8	96.6	99.0	0.0	50.0	75.0
November,	113	11	6	98.1	91.5	93.8	12.5	83.5	62.5
Average,	46	10	4	99.6	94.3	97.0	5.5	41.4	71.3

Effluent from the Lawrence City Filter (New Filter).

DATE.	BACTERIA PER CUBIC CENTIMETER.			PER CENT. OF BACTERIA REMOVED.			PER CENT. OF SAMPLES CONTAINING B. COLI.		
	20° C.	40° C. Total.	40° C. Red.	20° C.	40° C. Total.	40° C. Red.	1 c. c.	10 c. c.	100 c. c.
1910. December,	62	3	2	99.7	97.0	97.2	22.2	44.4	66.7
1911. January,	75	5	3	99.6	98.3	98.5	33.3	89.0	55.5
February,	160	17	7	98.9	91.5	95.6	0.0	28.6	85.7
March,	76	53	14	99.5	65.4	85.9	22.2	66.7	100.0
April,	34	37	22	99.5	56.5	68.6	12.5	37.5	75.0
May,	45	13	7	99.4	92.3	95.3	12.5	28.6	87.5
June,	42	11	5	99.6	96.1	97.9	42.8	83.5	100.0
July,	350	28	8	73.1	50.9	74.3	33.3	75.0	89.0
August,	17	5	2	99.3	94.4	97.0	50.0	83.5	100.0
September,	32	17	12	99.8	95.7	96.4	60.0	100.0	100.0
October,	26	6	2	99.6	94.8	97.9	12.5	62.5	75.0
November,	83	14	9	98.6	89.2	90.6	28.6	40.6	85.7
Average,	83	17	8	99.2	90.3	94.1	27.5	61.6	85.0

Average Bacterial Analyses.

Mixed Effluents as Pumped to Distributing Reservoir.

DATE.	BACTERIA PER CUBIC CENTIMETER.			PER CENT. OF SAMPLES CONTAINING B. COLI.		
	20° C.	40° C.				
		Total.	Red.	1 c. c.	10 c. c.	100 c. c.
1910.						
December,	90	5	1	11.1	44.4	77.8
1911.						
January,	53	14	6	11.1	33.3	100.0
February,	110	23	18	12.5	37.5	75.0
March,	60	8	3	0.0	60.0	80.0
April,	41	9	3	0.0	42.8	71.5
May,	16	8	3	0.0	12.5	55.6
June,	25	3	1	12.5	85.7	87.5
July,	79	20	10	20.0	11.1	80.0
August,	17	12	7	0.0	28.6	85.8
September,	46	5	4	33.3	100.0	100.0
October,	11	6	2	0.0	50.0	100.0
November,	45	11	3	0.0	33.3	87.5
Average,	49	10	5	8.4	44.9	83.4

Water from the Outlet of the Distributing Reservoir.

1910.						
December,	46	4	2	11.1	44.4	89.0
1911.						
January,	52	6	3	0.0	44.4	77.8
February,	71	5	2	0.0	37.5	87.5
March,	58	78	62	10.0	50.0	60.0
April,	51	10	4	0.0	25.0	75.0
May,	38	8	4	11.1	37.5	33.3
June,	24	3	1	12.5	28.6	75.0
July,	43	8	2	22.2	37.5	77.8
August,	31	1	0	0.0	16.7	66.7
September,	15	2	1	16.7	75.0	83.5
October,	9	4	2	0.0	62.5	62.5
November,	22	8	5	0.0	66.7	87.5
Average,	38	11	7	7.0	43.8	73.0

Average Bacterial Analyses.

Water from a Tap at Lawrence City Hall.

DATE.	BACTERIA PER CUBIC CENTIMETER.			PER CENT. OF SAMPLES CONTAINING B. COLI.		
	20° C.	40° C.				
		Total.	Red.	1 c. c.	10 c. c.	100 c. c.
1910.						
December,	60	4	2	0.0	44.4	89.0
1911.						
January,	85	6	3	0.0	44.4	87.5
February,	63	28	22	0.0	62.5	100.0
March,	51	7	4	0.0	60.0	80.0
April,	47	11	3	0.0	37.5	37.5
May,	94	7	2	0.0	12.5	22.5
June,	39	4	2	14.3	16.7	71.5
July,	45	6	2	0.0	37.5	44.5
August,	51	4	1	0.0	42.8	42.8
September,	69	4	1	16.7	50.0	100.0
October,	42	5	1	0.0	0.0	75.0
November,	29	6	2	0.0	33.3	75.0
Average,	56	8	4	2.6	36.8	68.7

Water from a Tap at the Lawrence Experiment Station.

1910.						
December,	45	4	2	0.0	34.6	88.5
1911.						
January,	40	12	8	3.8	26.9	88.5
February,	51	11	7	8.7	34.8	60.8
March,	48	11	5	0.0	29.6	89.0
April,	51	10	3	0.0	25.0	62.5
May,	29	5	2	0.0	0.0	30.7
June,	28	2	1	4.0	40.0	68.0
July,	27	4	1	8.3	26.0	62.5
August,	28	3	1	3.7	40.7	77.8
September,	15	3	1	16.0	52.6	80.0
October,	11	3	1	0.0	20.0	72.0
November,	27	5	1	0.0	42.8	84.0
Average,	33	6	3	3.7	31.1	72.0

SLOW SAND FILTERS, NOS. 8A AND 343.

Filter No. 8A, $\frac{1}{200}$ of an acre in area and first put into operation on Sept. 26, 1893, contained about 29 inches in depth of sand of an effective size of 0.28 millimeter at the beginning of the year. The average rate of operation during 1911 was 2,854,000 gallons per acre daily. During the year this filter was scraped to relieve clogging thirteen times, the total amount of sand removed by scraping being about 3 inches. This is equivalent to the removal of about 0.23 of an inch of sand at each scraping, or slightly less than 30 cubic yards per acre per scraping. The average volume of water filtered between scrapings was about 63,000,000 gallons per acre, the average time between scrapings being about twenty-three days. The longest run of the filter was from July 10 to August 22, when the filter was operated at the prescribed rate for thirty-eight days without scraping, about 110,000,000 gallons of water per acre being filtered in this period. The shortest run of the filter was in February, when only about 27,000,000 gallons per acre could be filtered, and the filter could be operated only about ten days before scraping was necessary.

Filter No. 343, $\frac{1}{20000}$ of an acre in area, was first put into operation on March 27, 1908, and contained about 33 inches in depth of sand of an effective size of 0.35 millimeter at the beginning of the year. The average rate of operation during 1911 was 5,064,000 gallons per acre daily. The surface of this filter was washed twenty-six times during the year, or about once in two weeks, the average amount of water filtered between washings being about 69,000,000 gallons per acre.

As stated previously, owing to the extremely small rainfall the river water was much more difficult to purify than usual, and this undoubtedly affected the work of these and other water filters at the station. Filter No. 8A, constructed of the grade of sand usually recommended for municipal filters, and operated at a rate similar to that at which such filters are usually operated, has yielded an effluent of excellent quality, bacterially speaking, throughout the year. Filter No. 343, on the other hand, which has been in operation for a much shorter period, and is constructed of a much coarser grade of sand and operated at a much higher rate than is usually the practice when dealing with a water of the character of the Merrimack River, has yielded an effluent of less satisfactory quality than that from Filter No. 8, although one which would compare favorably with filtered waters which are used for municipal supplies in many places.

The average number of bacteria in the effluent from Filter No. 8A was 53 per cubic centimeter, and in the effluent from Filter No. 343, 160 per cubic centimeter. The total numbers of bacteria exceeded 100 per cubic centimeter about 15 per cent. of the time in the effluent from Filter No. 8, and about 18 per cent. of the time in the effluent from Filter No. 343. Samples containing 1,000 or more bacteria per cubic centimeter were also obtained from the latter filter about 3 per cent. of the time, but no such high results were obtained from Filter No. 8 at any time during the year. The average bacterial efficiencies of these two filters were 99.1 per cent. for Filter No. 8A, and 97.2 per cent. for Filter No. 343; and B. coli were found in one cubic centimeter in about one-fourth of the samples of the effluent from Filter No. 8A, and in about 32 per cent. of the samples collected from Filter No. 343.

The average analyses of the Merrimack River water applied and of the effluents from these two filters are shown in the following tables: —

Average Chemical Analyses.

Canal Water (Merrimack River Water).

[Parts per 100,000.]

Quantity applied, — Gallons per Acre Daily.	Temperature (Degrees F.).	APPEARANCE.		AMMONIA.			Chlorine.	NITROGEN AS		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	ALBUMINOID.			Nitrates.	Nitrites.			
					Total.	In Solution.						
-	53	0.3	.29	.0255	.0224	.0190	0.49	.017	.0007	0.64	51.5	1.4

Effluent from Filter No. 8A.

2,854,000	52	0.0	.21	.0106	.0127	-	0.51	.021	.0002	0.50	17.8	1.4

Effluent from Filter No. 343.

5,064,000	53	0.0	.26	.0137	.0135	-	0.48	.020	.0001	0.52	23.8	1.4

Average Bacterial Analyses.

Canal Water (Merrimack River Water).

BACTERIA PER CUBIC CENTIMETER.			PER CENT. OF BACTERIA REMOVED.			PER CENT. OF SAMPLES CONTAINING B. COLI.
20° C.	40° C.		20° C.	40° C.		1 c. c.
	Total.	Red.		Total.	Red.	
5,700	150	100	-	-	-	100.0

Average Bacterial Analyses—Concluded.

Effluent from Filter No. 8A.

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
53	10	4	99.1	93.3	96.0	25.9

Effluent from Filter No. 343.

160	10	5	97.2	93.3	95.0	32.8

STUDIES OF THE RELATIVE EFFICIENCY OF SAND FILTERS OPERATED AT DIFFERENT RATES.

Filters Nos. 417, 418, 419 and 420.

During the years 1908, 1909 and 1910 four filters, each containing the same depth and character of sand, were operated at widely different rates to study comparatively the effect of the rate of operation upon the hygienic efficiency and operating economy of such filters. These filters, however, had each been operated previously at a different rate and for a different period, and as pointed out in the report of last year, the comparison of the influence of different rates was hardly a fair one, since the results were undoubtedly influenced to a greater or less extent by the different age and particularly by the amount and character of the clogging material which the different filters had stored previous to the beginning of the experiment. On Dec. 28, 1910, therefore, four new filters were put into operation to begin this study anew. Each of these filters was constructed of 4½ feet in depth of sand of an effective size of 0.25 millimeter. Filter No. 417 has been operated at a theoretical rate of 2,500,000 gallons per acre daily, Filter No. 418 at a rate of 5,000,000 gallons, Filter No. 419 at a rate of 10,000,000 gallons and Filter No. 420 at a rate of 20,000,000 gallons per acre daily.

The average numbers of bacteria in the effluents from these filters have been 840 per cubic centimeter for Filter No. 417, 855 for Filter No. 418, 790 for Filter No. 419 and 1,070 for Filter No. 420, these figures corresponding to bacterial removals of 85.3, 85.0, 86.2 and 81.2 per cent., respectively. B. coli were found in the effluent from Filter No. 417 in 29 per cent. of the samples; in the effluent from Filter No. 418 in about 27 per cent. of the samples; in the effluent from Filter No.

419 in about 24 per cent. of the samples; and in the effluent from Filter No. 420 in about 57 per cent. of the samples.

These results are far from satisfactory, and the influence of the different rates of operation is not apparent. The filters were started, however, at a time when the river water was more difficult to purify than in former years, and all of the filters were very slow in coming to maturity. During the latter part of April and the first part of May they had apparently matured, and the numbers of bacteria in the effluents from all the filters were low. With the beginning of warm weather, however, the bacterial counts became very erratic and fluctuated within wide limits. The plates showed that the bacteria causing the high counts were of one or two kinds, proving that the trouble was due to growths of bacteria within the filters. During these summer months, also, the amount of dissolved oxygen in the canal water was low, and this oxygen was practically all used up in the passage of the water through the filters. Conditions favorable to the growth of bacteria within water filters have not occurred to any extent at the station for many years past. During the years 1895, 1896 and 1897, however, conditions were favorable and much trouble of this nature was experienced, and the causes and effects of such growths of alien bacteria were discussed in the reports for these years. For these reasons the results in the accompanying tables probably do not show the true effect of different rates of operation, although they do show what kind of results may be obtained with new filters when operated at these rates under the conditions which prevailed during the past year.

Effect of Rates upon Operating Results.

In addition to the comparative determination of the relative hygienic efficiency, one of the objects of this investigation has been to obtain comparative data as to the amount of mechanical treatment required to maintain these various rates of filtration. It has been the practice in the operation of these filters, as with many other experimental filters at the station during recent years, whenever the loss of head has become so great that the theoretical rate could not be maintained, to remove clogging materials by washing the surface of the sand in place as described on page 249 of the report for 1906; that is, to clean the surface by what is now generally known as the "Brooklyn method." By surface washing in this manner the effective depth of sand in the various filters has been kept much more uniform than would have been the case had the clogged sand been removed from the filter by scraping, which is the more usual practice. As has been found in many places where this method of cleaning has been used on large filters, satisfactory reduction in the loss of head cannot always be obtained by the practice of surface washing, and at times it has been necessary to resort to other remedies in order to maintain the filters in operation at or near the prescribed rates. The various remedies tried at different times in addition to surface washing comprised scraping, digging over the surface sand to a depth of about 6 inches, and washing the upper layers of sand to a depth of about 12 inches by means of a rake having hollow teeth through which jets of water were forced under pressure into the sand. The comparative operating records of these different filters, although extending over a period of eleven months only, have yielded some very interesting and practical data as to the relative efficiency of these various methods of surface treatment.

Filter No. 417, operating at a rate of 2,500,000 gallons per acre daily, required no surface treatment of any kind during the first six months of its history, in which period 447,000,000 gallons of water per acre were filtered. On June 30 the surface of this filter was scraped, instead of being surface washed, through a misunderstanding of orders by a filter attendant. No further surface treatment was necessary up to November 30, but on December 16 it was again necessary to relieve clogging and the surface was washed. During this period of eleven months and twenty days, therefore, in which about 852,000,000 gallons of water per acre were filtered, only two surface treatments were required.

Filter No. 418, operating at a rate of 5,000,000 gallons per acre daily was washed six times up to the end of the year. The first surface treatment required by this filter was on April 19, three months and twenty-two days after starting. The total quantity of water filtered up to the first washing was 582,000,000 gallons, and the average quantity filtered between each of the subsequent washings was about 192,000,000 gallons per acre.

Filter No. 419, operating at a theoretical rate of 10,000,000 gallons per acre daily, was washed fifty-six times, was dug over to a depth of 6 inches once and was washed with the water rake to a depth of about 12 inches twice. The surface of this filter required cleaning for the first time on January 21, or twenty-three days after being started, during which period 240,000,000 gallons of water per acre were filtered. Omitting the periods subsequent to other methods of surface treatment, the average volume of water filtered between washings was about 50,000,000 gallons per acre. After digging over to a depth of 6 inches the filter passed about 129,000,000 gallons per acre before surface treatment was again necessary. On the two occasions when the water rake treatment was used, the volume of water passed before surface treatment was again necessary, in one case was about two and one-half times the amount passed during the period just before water raking, and in the other case the volume of water filtered during the succeeding period was much less than the amount passed during the period just before treatment.

The theoretical rate of 20,000,000 gallons per acre daily at which it has been attempted to operate Filter No. 420 appears to approach the maximum limit at which a filter of this depth and material can be operated, and in spite of frequent surface treatment throughout the year the average rate of operation was only about 17,000,000 gallons per acre daily. The surface of this filter was washed one hundred and twelve times, scraped twice, dug over to a depth of 6 inches twelve times, and washed to a depth of 12 inches with the water rake fourteen times, during the period of eleven months the filter was in operation. The first surface treatment of this filter was given on January 13, fifteen days after the filter was started, during which period about 300,000,000 gallons of water per acre were filtered. Omitting the periods following other methods of surface treatment, the average volume of water filtered between surface washings was about 46,000,000 gallons per acre daily. In the periods immediately following scraping, between 65,000,000 and 70,000,000 gallons of water per acre were filtered before surface treatment was again necessary. During the periods immediately following digging over the surface to a depth of 6 inches, the average volume of water filtered before surface treatment was again required was about 88,000,000 gallons per acre. As in Filter No. 419, the agitation of the upper 12 inches of sand by means of the water rake failed as a rule to produce results commensurate with the labor involved. Twice out of the fourteen times that this treatment was tried there was no reduction in the loss of head, and other treatment was required before the filter could be operated at the prescribed rate. On four other occasions the volume of water filtered during the period immediately following water-raking was from 11 to 58 per cent. less than the volume passed in the period preceding such treatment. In the eight other instances when this process was used the volume of water filtered in the period following the water-raking was from 12 to 140 per cent. more than was filtered in the period immediately preceding water-raking. Omitting the two instances when the process afforded no relief whatever, the volumes after treatment showed an average increase of about 20 per cent. over those of the periods preceding the treatments.

The increased frictional resistance due to air entrained in sand filters has been discussed frequently in the reports. Trouble of this character is always more serious in the winter when the water is practically saturated and at times supersaturated with air, and always more noticeable in the operation of sand filters in which the rates are high and the loss of head correspondingly large (much negative head) than in the case of filters operated at lower rates. This has been true in the operation of this series of filters. Considerable trouble was experienced during February and March on account of entrained air in Filter No. 420, and part of the surface treatment applied during these months was for the purpose of liberating this air. Some trouble of this nature was also experienced in the operation of Filter No. 419 during these months, but to a markedly less extent than in the case of the filter operated at the higher rate, and very little trouble of this kind was found in the filters operated at the lower rates.

Average Chemical Analyses.

Effluent from Filter No. 417.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.			
2,533,000	55	0.0	.16	.0216	.0125	0.47	.017	.0008	0.42	20.1	1.5

Effluent from Filter No. 418.

5,143,000	54	0.0	.19	.0160	.0133	0.46	.023	.0005	0.48	27.7	1.4

Effluent from Filter No. 419.

9,467,000	54	0.0	.21	.0122	.0137	0.47	.024	.0006	0.49	27.1	1.3

Effluent from Filter No. 420.

17,019,000	53	0.1	.23	.0156	.0151	0.47	.021	.0008	0.54	26.6	1.3

Effluent from Filter No. 417.

1911.	BACTERIA PER CUBIC CENTIMETER.			PER CENT. OF BACTERIA REMOVED.			PER CENT. OF SAMPLES CONTAINING B. COLI.
	20° C.	40° C.		20° C.	40° C.		1 c. c.
		Total.	Red.		Total.	Red.	
January, . . .	1,800	18	13	80.0	92.5	92.8	28.0
February, . . .	1,000	17	9	82.8	90.3	93.1	26.0
March, . . .	150	15	5	97.3	86.4	91.2	0.0
April, ...	36	22	4	98.9	75.6	91.8	0.0
May, ...	23	16	5	99.5	88.3	95.5	0.0
June, ...	1,600	11	6	75.0	97.0	97.0	66.7
July, ...	550	11	5	42.0	84.3	85.5	55.6
August, . . .	440	14	9	45.7	79.5	80.5	55.6
September, . . .	1,160	10	6	84.5	94.8	95.7	75.0
October, . . .	1,800	9	1	61.7	90.0	98.5	0.0
November, . . .	650	5	2	90.7	97.6	98.8	12.5
Average, . .	840	13	6	85.3	91.3	94.0	29.1

Effluent from Filter No. 418.

January, . . .	2,700	20	8	70.0	91.7	95.6	44.0
February, . . .	900	14	6	84.5	92.0	95.4	21.7
March, . . .	205	17	7	96.3	84.5	87.8	3.7
April, ...	43	23	5	98.7	74.4	89.8	0.0
May, ...	29	17	5	99.3	88.7	95.5	0.0
June, ...	400	11	5	93.7	97.0	97.5	66.7
July, ...	480	11	5	49.5	84.3	85.5	33.3
August, . . .	370	11	8	54.3	84.0	82.6	44.5
September, . . .	375	7	4	95.0	96.4	97.1	25.0
October, . . .	3,300	30	26	29.8	66.7	60.6	11.1
November, . . .	600	10	5	91.4	95.2	96.9	50.0
Average, . .	855	16	8	85.0	89.3	92.0	27.3

Effluent from Filter No. 419.

1911.	Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
	20° C.	40° C.		20° C.	40° C.		
		Total.	Red.		Total.	Red.	1 c. c.
January, . . .	2,260	160	60	75.3	33.3	66.7	36.0
February, . . .	670	14	6	88.5	92.0	95.4	34.7
March, . . .	150	14	5	97.3	87.3	91.2	7.7
April, ...	310	27	6	90.3	70.0	87.8	12.5
May, ...	46	13	5	98.9	91.3	95.5	16.7
June, ...	225	8	4	96.5	97.8	98.0	11.1
July, ...	670	11	6	29.5	84.3	82.5	44.5
August, . . .	2,100	10	8	–[1]	85.3	82.6	55.6
September, . . .	1,700	4	2	77.3	97.9	98.6	25.0
October, . . .	410	8	3	91.3	91.0	95.5	0.0
November, . . .	170	10	6	97.6	95.2	96.3	25.0
Average, . .	790	25	10	86.2	83.3	90.0	24.4

[1] Increase.

Effluent from Filter No. 420.

January, . . .	2,300	27	16	74.2	88.8	91.1	40.0
February, . . .	850	20	9	85.4	88.6	93.1	43.5
March, . . .	730	31	12	87.0	71.8	79.0	48.0
April, ...	575	29	5	82.0	67.8	89.8	43.5
May, ...	71	12	8	98.3	92.0	92.7	25.0
June, ...	400	13	10	93.7	96.5	95.0	55.6
July, ...	545	17	11	42.6	75.7	67.6	89.0
August, . . .	3,600	39	32	–[1]	42.7	30.4	89.0
September, . . .	1,970	10	7	73.7	94.8	94.9	100.0
October, . . .	330	4	1	93.0	95.6	98.5	33.3
November, . . .	425	14	10	93.9	93.3	93.8	62.5
Average, . .	1,070	20	11	81.2	86.7	89.0	57.2

[1] Increase.

DOUBLE FILTRATION.

Filters Nos. 331 and 286.

Filter No. 331, 1/80000 of an acre in area is constructed of 18 inches in depth of sand of an effective size of 0.45 millimeter, and was first put into operation on July 7, 1907. This filter has been operated as a pre-filter, the canal water applied being first passed through a settling basin having a storage capacity of about ten hours. The effluent from pre-filter No. 331 is pumped into a storage tank from which it is applied to secondary Filter No. 286. Filter No. 286, 1/20000 of an acre in area, and containing 4 feet in depth of sand of an effective size of 0.21 millimeter, was first put into operation on Jan. 20, 1906. Pre-filter No. 331 has been operated at a rate of 50,000,000 gallons per acre daily and secondary Filter No. 286 has been operated at a rate of 5,000,000 gallons per acre daily, throughout the year, the net rate of the double filtration system as a whole being about 4,500,000 gallons per acre daily.

The entire body of sand in Filter No. 331 was washed by reversed flow, in the same way that mechanical filters are washed, eighty-seven times during the year, or on an average of about once in four days. The average quantity of water filtered between washings was about 174,000,000 gallons per acre. During the winter the filter required washing much less frequently than in the summer. During January and February it was necessary to wash the filter only three times, or at average intervals of about twenty days, while in July and August it was necessary to wash the filter thirty-three times, or about every other day. The relative volumes of water filtered between washings in winter and summer were 480,000,000 gallons and 84,000,000 gallons per acre, respectively. During September and October the volume of water passed between washings gradually increased, and by the end of November the volumes were practically the same as during the winter months. The surface of secondary Filter No. 286 was scraped fifteen times during the year, or on an average once in eighteen days, the average quantity of water filtered per scraping being about 86,000,000 gallons per acre. The longest run of this filter without surface treatment was from April 3 to June 17, a period of fifty-seven days, during which about 285,000,000 gallons of water per acre were filtered. During the summer months the average time between scrapings was about thirty-three days, while during the winter months the average time between scrapings was only about ten days, and the records show four scraping intervals of less than seven days during the colder months.

The increased difficulty in keeping the pre-filter in operation during the summer months is very unusual and cannot be satisfactorily explained at this time. All of the experimental filters have required somewhat more frequent surface treatment than in previous years, but this increased treatment has generally been found necessary during the colder months of the year. This was the case with the secondary filter as noted above, and with the other filters described elsewhere, and is caused by a combination of three well-known factors: (1) the increased viscosity of the water at low temperatures; (2) the presence of entrained air in the sand owing to the saturation or oversaturation of the water with oxygen in the winter; and (3) the somewhat larger amounts of suspended matters in the river water during the winter and early spring. In the case of the pre-filter, however, the most serious difficulty was encountered at a time when the water was warm, when the amount of dissolved oxygen was exceptionally low, and when the water was unusually free from suspended matters. It was suspected that the trouble might be due to growths of microscopical organisms within the filter or in the preliminary settling basin. Careful examinations proved, however, that while there was a growth of bacteria in the settling basin there was nothing of this nature present which could account for the unusual clogging of the filter.

During the months of February, April, June, July and August the numbers of bacteria increased during the passage of the canal water through the settling tank before its application to the pre-filter. This increase, which was especially large in the month of June, greatly overbalanced the decrease in numbers which occurred during the remaining months of the year, with the result that the yearly averages show an increase of about 30 per cent. in the numbers of bacteria in the water after passing through the settling tank. During passage through the pre-filter there was an average decrease in the bacterial content of the water of about 37 per cent. In the tank where the effluent from the pre-filter was stored before being applied to secondary Filter No. 286, there was again an increase in the numbers of bacteria amounting to about 36 per cent., the result being that the water as applied to the secondary filter contained on an average more bacteria than the canal water before treatment. The average removal of bacteria by the secondary filter was about 92 per cent., while, owing to the increases above noted, the bacterial efficiency of the entire system of double filtration was only 90 per cent. This system of double filtration shows more clearly, perhaps, than other types of filters the exceptional character of the river water during the past year. As has already been stated, owing to the extremely low stage of the river, the river water has received much longer storage in the mill ponds above Lawrence than usual, and a much greater opportunity for sedimentation has been afforded than has generally been the case in previous years. The result has been that all or practically all settleable materials had been eliminated when the water reached the settling basin. It was not to be expected, therefore, that much additional clarification would be accomplished in the settling basin. On the contrary, in this settling basin, especially during the unusually hot months of July and August, favorable conditions were provided for a growth of saprophytic bacteria in the water. Furthermore, the water being practically devoid of suspended matters, and containing extremely large numbers of bacteria, was not purified to such an extent as would have been the case under normal conditions. The secondary increase in bacteria in the effluents from the pre-filter during storage — an increase which has been noted in previous years and which may be stated to be a normal occurrence — was exceptionally large this year during the months of July and August. The previous history of the water and the extreme temperature of the two months noted, offer a rational explanation of the apparently abnormal results obtained during the year 1911. As has been stated elsewhere, while the results obtained with this system of double filtration during the year are disappointing when viewed in connection with those obtained in other years, they are nevertheless extremely valuable in demonstrating what such a system of filtration can or cannot accomplish under especially difficult conditions.

The average results of the operation of this double filtration system are shown in the following tables: —

Average Chemical Analyses.

Effluent from Primary Filter No. 331.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.			
48,676,000	49	0.2	.31	.0293	.0214	.58	.026	.0009	.57	43.6	1.3

Effluent from Secondary Filter No. 286.

4,808,000	49	0.0	.23	.0050	.0128	.58	.048	.0002	.41	51.5	1.3

Average Bacterial Analyses.

Settling Tank Effluent applied to Filter No. 331.

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
7,400	140	110	29.8[1]	6.7	10.0[1]	100.0
Effluent from Pre-Filter No. 331.						
4,700	80	60	36.5	42.8	45.5	100.0
Stored Effluent as applied to Secondary Filter No. 286.						
6,400	110	90	36.2[1]	37.5[1]	50.0[1]	91.5
Effluent from Secondary Filter No. 286.						
530	18	11	91.7	83.6	87.8	59.2
Bacterial Efficiency of Entire System.						
-	-	-	90.7	88.0	89.0	-

[1] Increase.

MECHANICAL FILTRATION.

Filter No. 336.

Filter No. 336, $\frac{1}{40000}$ of an acre in area, and containing 24 inches in depth of sand of an effective size of 0.35 millimeter, was first put into operation on Dec. 11, 1907. This filter has been operated as a mechanical filter at a rate of 100,000,000 gallons per acre daily with canal water which has been treated with sulphate of alumina and soda ash and passed through a settling tank with a storage capacity of three and one-fourth hours.

By the operation of this filter in 1908 it was shown that an effluent of reasonably satisfactory bacterial quality might be obtained by the use of about 2.0 grains sulphate of alumina and 1.5 grains soda ash per gallon, and during 1909 and 1910 it was shown that by the addition of small amounts of a disinfectant, such as hypochlorite of lime, an effluent of excellent bacterial quality and of satisfactory physical appearance could be produced by the use of about 1.0 grain of sulphate of alumina and 0.75 of a grain of soda ash per gallon. During 1911 this filter has again been operated as nearly as possible in the same manner as during the year 1908, no disinfectant being used to increase the bacterial efficiency. Operated in this manner it has been necessary to use over 2.0 grains sulphate of alumina and about 1.25 grains soda ash, and even with these amounts of coagulants unassisted by disinfection, the numbers of bacteria in the effluent from the filter have not been entirely satisfactory. The average numbers of bacteria in the canal water before treatment were 5,700 per cubic centimeter. After coagulation and sedimentation the numbers of bacteria in the water as applied to the filter were 3,200 per cubic centimeter, and after passing through the filter the numbers were reduced to an average of 540 per cubic centimeter. In other words, about 44 per cent. of the bacteria in the canal water were removed in the coagulation basin, and about 83 per cent. of the bacteria remaining after coagulation were removed by the filter. The bacterial efficiency of the entire system, however, was only about 90 per cent. Bacterially, therefore, the effluent from this filter was not nearly so satisfactory as in the years when coagulation with smaller amounts of chemicals was practiced and a disinfectant was used to assist in the elimination of bacteria. Chemically speaking, the effluent from this filter was somewhat better than during the two previous years, owing to the greater clarification and color removal accomplished by the increased amounts of coagulants.

As is usual with filters of this type the entire body of sand was washed by reversed flow whenever the filter became so clogged that the prescribed rate of filtration could not be maintained. The average time which the filter could be operated without washing during the year was about six hours and thirty-six minutes, the average quantity of water filtered between washings being 27,600,000 gallons per acre. The quantity of water filtered between washings was much smaller than during the two preceding years owing to the more voluminous precipitate caused by the larger amounts of coagulant used to obtain a satisfactory effluent.

The average results of the operation of this filter during the year are shown in the following tables: —

Average Chemical Analyses.

Effluent from Coagulation Basin.

[Parts per 100,000.]

Temperature (Degrees F.).	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.			
57	0.4	.23	.0255	.0218	.52	.018	.0007	.56	38.9	1.5

Effluent from Filter No. 336.

57	0.0	.12	.0241	.0127	.53	.020	.0005	.35	57.6	1.6

Average Bacterial Analyses.

Effluent from Coagulation Basin.

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
3,200	48	33	43.9	68.0	67.0	47.6

Effluent from Filter No. 336.

540	10	7	83.2	79.2	78.8	27.7

Bacterial Efficiency of Entire System.

-	-	-	90.5	93.3	93.0	-

CLARIFICATION BY UPWARD FILTRATION THROUGH A ROUGHING FILTER OF COARSE MATERIAL.

Filter No. 389.

Filter No. 389, 1/20000 of an acre in area, was first put into operation on April 14, 1910. This filter is constructed of 6 inches in depth of wood charcoal supported upon a 1/4-inch mesh galvanized wire screen placed 12 inches above the bottom of the tank. Overlying the charcoal and separated from it by a 1/8-inch mesh copper screen, is 24 inches in depth of broken stone pebbles of an effective size of 4.4 millimeters. The canal water enters at the bottom, passes upward through the filter material and overflows through an orifice placed 3 inches above the surface of the stone, the available loss of head with the filter in operation being about 10 inches. This filter was continued in operation during the first four months of the year at a rate of about 10,000,000 gallons per acre daily. On April 6 the operation of the filter was temporarily suspended, and it was not again put into operation until after the end of the year. During the four months of the year in which it was operated the filter was washed by reversing the flow for a short period twenty-four times, the average volume of water filtered between washings being about 44,000,000 gallons per acre daily. As stated in the report for last year this filter cannot be considered as other than a roughing filter to prepare the water for ultimate treatment by some other process. From this viewpoint the work of the filter was extremely satisfactory. During February and March, before the operation of the filter was suspended, the numbers of bacteria in the effluent had decreased to 220 and 160 per cubic centimeter, respectively, corresponding to bacterial efficiencies of over 96 per cent., — efficiencies which compared well with those obtained at times with filters constructed of much finer materials when operated at similar rates.

The average results of the operation of this filter during these four months are shown in the following table: —

Average Chemical Analyses.

Effluent from Filter No. 389.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.			
8,799,000	38	0.0	.27	.0170	.0164	.61	.032	.0002	.52	32.3	1.4

Average Bacterial Analyses.

Effluent from Filter No. 389.

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	40° C.		20° C.	40° C.		1 c. c.
	Total.	Red.		Total.	Red.	
740	24	10	91.2	84.0	90.0	48.3

Note. — Average of four months only. Filter stopped April 6, 1911.

PURIFICATION OF WATER BY A SPRINKLING FILTER OF SAND.

Filter No. 390.

Filter No. 390, $\frac{1}{20000}$ of an acre in area and constructed of 54 inches in depth of sand of an effective size of 0.42 millimeter, was first put into operation on April 21, 1910. The canal water has been applied to the surface of this filter by means of a tipping basin discharging into a perforated pan placed 12 inches above the surface, the outlet of the filter being kept wide open at all times, and the rate of operation controlled at the influent pipe. The practice has been to rake the surface of the filter to a depth of 1 inch whenever pooling of the water on the surface occurred, and to scrape or dig over the surface when no further relief could be obtained by raking. During the period from December 1 to February 3, canal water was thus applied to the filter at a theoretical rate of 5,000,000 gallons per acre daily. During this period the filter was operated sixty-three days, and in spite of the fact that the surface was raked fifty-seven times, and 1 inch in depth of the surface sand was removed on January 18, water stood on the surface practically all the time. On February 3 the rate was reduced to 2,500,000 gallons, at which rate the filter was operated throughout the remainder of the year. With the decreased rate it was somewhat easier to keep the filter in operation. Nevertheless, during this period in which the filter was in actual operation, two hundred and eighty-four working days, it was necessary to rake the surface one hundred and two times, or on an average at intervals of less than once in three days, and in addition to raking, the surface was scraped twice, was dug over to a depth of 6 inches twice, the entire body of sand in the filter was washed by reversed flow once, and on two occasions the filter was allowed to drain and rest for a period of one week. The mechanical difficulties in keeping a filter of this type in operation would apparently increase the cost of filtration to an unreasonable figure. The actual volume of water passed by the filter between rakings was only about 4,500,000 gallons per acre during the period when operated at the higher rate, and only about 5,000,000 gallons per acre when operated at the lower rate.

The results obtained with this filter, with a water which was more difficult to purify than usual, were excellent; better, in fact, than those obtained with any of the other filters operated at the station during the year. At no time during the year did the numbers of bacteria in the effluent exceed 100 per cubic centimeter, while the average number was only 37 per cubic centimeter, and B. coli were found in only about 12 per cent. of the samples. These are much better results than were obtained with either Filter No. 8A or the old city filter, both slow sand filters operated at low rates. The superior results obtained with this filter can only be attributed to the increased amount of oxygen in the water owing to the method by which this water was applied to the filter, and to the increased nitrification within the filter consequent upon the presence of an unlimited supply of oxygen for the completion of the purification processes.

The average results obtained during the year are shown in the following tables: —

Average Chemical Analyses.

Effluent from Filter No. 390.

[Parts per 100,000.]

Quantity applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.			
2,346,000	53	0.0	.19	.0039	.0101	.49	.035	.0000	.42	63.9	1.3

Average Bacterial Analyses.

Effluent from Filter No. 390.

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
37	8	4	99.3	94.7	96.0	11.8

EXPERIMENTS UPON THE DISINFECTION OF SEWAGE AND THE EFFLUENTS FROM SEWAGE FILTERS.

By H. W. CLARK and STEPHEN DEM. GAGE.

A large number of experiments have been made at the experiment station during the past ten years to determine the effectiveness of various disinfectants in destroying the bacteria in water, sewage and the effluents from sewage filters. In these investigations the studies of both water and sewage disinfection have been carried out simultaneously, the difference between water and sewage, as far as disinfection is concerned, being one of degree of pollution only. The more important data upon the disinfection of water have already been published, the results of experiments upon the value of copper and its salts in water purification being given on pages 288 to 338, inclusive, of the report for 1905, and studies of the use of hypochlorite of lime as an adjunct to water purification being given on pages 317 to 332, inclusive, and pages 278 to 283, inclusive, of the reports for 1909 and 1910, respectively. In the following pages are given certain of the more important data obtained in these investigations upon the disinfection of sewage and the effluents from sewage filters.

By far the most satisfactory results have been obtained by the use of the hypochlorites, of which the compound variously known as hypochlorite of lime, chloride of lime or bleaching powder is the most common and most readily and cheaply obtained. The efficiency of this group of disinfectants is due to the fact that they are easily dissociated in solution with the liberation of nascent oxygen, and while by long-established custom it has been the practice to express the strength of solutions of these disinfectants in terms of the amount of available chlorine, it is the oxygen which is the active agent in the disinfection. Similar in action to the hypochlorites are other oxidizing agents such as permanganates, peroxides, ozone, etc. All the disinfectants of the oxidizing type act not only upon the bacteria, but also upon any readily oxidizable organic matter which may be present, and for this reason the condition of the sewage or effluent as regards avidity for oxygen is an important factor in determining the amount of disinfectant required for disinfection.

Unlike the metallic salts and certain organic substances which act as sterilizing agents through their poisonous properties, the hypochlorites and other disinfectants of the oxidizing type entirely lose their identity during the disinfection process, and the further disposal of the disinfected sewage is affected only by the fact that the bacteria necessary for self-purification have been to a greater or less extent removed.

The data here given are from two sources. A large number of experiments have been made in the laboratory in which gallon samples of the sewage or effluent under investigation were treated with varying amounts of the disinfectant, and were examined bacteriologically after standing for periods of one, two, four, six, and twenty-four hours or longer. In the investigation of the action of hypochlorites, not only was the experimental treatment of each sewage or effluent repeated at least once after an interval of some days or weeks, but similar experiments were made with effluents from other filters of the same type. These data therefore show not only the approximate amount of disinfectant required to obtain a given result, and the effect of the time during which the disinfectant was allowed to act upon that result, but also show what effect the usual fluctuations in composition of sewages and sewage effluents may have upon the disinfection process. Similar but much less extensive studies have also been made of a number of other disinfectants, the results of which are summarized. Supplementary to the above experiments with the hypochlorites were those in which the entire volume of sewage applied to, or the entire effluent from, certain of the experimental filters at the station was treated daily with hypochlorites. The effect of disinfection of the sewage prior to filtration upon the purification processes taking place within a filter were discussed in detail on pages 358 to 363 of the report for the year 1908, and need not be taken up at this time.

STANDARDS OF DISINFECTION. — METHOD OF EXPRESSING RESULTS.

There are two ways of looking at the results of the disinfection of sewage and the effluents from sewage filters. In Germany, where disinfection of hospital sewage is compulsory, and where municipal sewage is required to be sterilized during cholera epidemics, absolute sterilization is aimed at, and it is considered necessary to add the disinfectant in such proportions that the test organisms, usually B. coli, shall be absent from all 1 cubic centimeter samples and shall be only occasionally present in samples of 100 and 1,000 cubic centimeters. Practically all of the numerous German experiments on sewage disinfection have been made with this in view, and the results have been presented with reference to the bacterial content of the liquid after disinfection, irrespective of the numbers originally present. On the other hand, some American investigators have laid considerable emphasis upon the percentage of the original numbers of bacteria which have been destroyed by disinfection, but have entirely omitted to discuss, or have given scant attention to, the significance of the numbers of bacteria which remain after disinfection. Of these two viewpoints the former, in which the final bacterial content is made the criterion, appears to be the most logical, although the standards recommended by the German investigators are much more severe than are necessary for average American conditions. If the object in sterilization is to prevent the carriage of some specific disease at times of epidemics, or if the sterilized sewage or effluent from a sewage filter is to be turned into a lake or river which is to be used without further purification as a source of water supply, then absolute sterilization is undoubtedly desirable. If, however, the body of water which is to receive the final effluent is already polluted, and the object in sterilization is only to prevent further contamination, then the standard may be lowered to meet the local need. In either case, however, the numbers of bacteria in the liquid after sterilization should be made the basis of comparison. In presenting the results of these experiments both methods of expression have been employed, and since standards may vary with local conditions, a number of arbitrary standards have been assumed for the purpose of discussion.

Three separate counts of bacteria — *i.e.*, total colonies on agar plates incubated four days at room temperature and total and red colonies on litmus lactose agar plates incubated twenty-four hours at body temperature — have been made on all samples. It has been found that waters in Massachusetts suitable for drinking usually contain less than 100 bacteria per cubic centimeter determined at room temperature, and that the total number of bacteria developing on litmus lactose agar at body temperature is usually less than 10 per cubic centimeter and the number of red colonies on such plates is usually less than 5 per cubic centimeter. This we have called the "drinking water" or "100–10–5" standard. For purposes of comparison two other standards containing, respectively, 10 and 100 times as many bacteria as the drinking water standard, and designated the "1,000–100–50" and the "10,000–1,000–500" standards, have been assumed. These latter correspond approximately to the upper and lower limits of bacterial counts on river waters receiving more or less pollution.

In the tables of results, therefore, will be found stated the amounts of disinfectant by which the bacterial content of each sample was reduced to each of these three arbitrary standards, together with the initial numbers of bacteria in those samples before disinfection. For purposes of comparison, the amounts of disinfectant by which absolute sterilization, and reductions in the bacterial contents of 75 per cent., 90 per cent. and 99 per cent., respectively, were produced are also given. As the proportions of disinfectant in successive portions of the same sample were always increased by uniform increments, it is probable that in many cases the amount stated as producing a given effect may be somewhat greater than the actual amount necessary to produce that effect. The experimental results showed, however, that the next smaller amount tried was not sufficient to produce that effect. As previously stated, all of the samples in the bottle experiments were analyzed at intervals of one, two, four, six and twenty-four hours after the disinfectant was added. The tabulated results, however, are all based on a two to four hour disinfection, since in actual practice the time allowed for disinfection would not probably exceed four hours. The effect of the time during which the disinfectant is permitted to act upon the bacterial content of the various types of samples will be discussed separately.

EXPERIMENTS WITH VARIOUS AMOUNTS OF CALCIUM HYPOCHLORITE.

In this series of experiments the sewages or effluents from sewage filters were divided into aliquot parts which were treated with hypochlorites in gradually increasing amounts, and determinations of bacteria were made after one, two, four, six and twenty-four hours. The effect of allowing the disinfectant to act for varying periods of time will be discussed later. In practice, four hours' disinfection would probably be the limit, as the improvement obtained by a longer period would probably not warrant the extra cost of the larger tanks necessary to retain the sewage. For this reason the two and four hour results have been selected for comparison and discussion.

Sewages.

In all, eleven experiments were made with different kinds of sewages, including the untreated and the settled Andover sewage and the Lawrence sewage before and after treatment by settling, by straining and by septic tanks. The initial numbers of bacteria in these sewages ranged from 735,000 to 2,340,000 per cubic centimeter. In the majority of cases treatment with 0.38 part available chlorine caused a bacterial reduction of 75 to 90 per cent. Treatment with 0.75 part was required to produce a reduction of 75 per cent. in the total bacteria in two experiments, and a similar reduction in the body temperature types in three experiments, and the same amount was required to cause a 90 per cent. reduction in the body temperature counts in four experiments. In only one experiment was a completely sterile effluent produced by the maximum amount of chlorine used, 3.75 parts per 100,000. In general, a reduction of total bacteria to less than 100 per cubic centimeter was produced by available chlorine equal to 1.88 parts per 100,000 or less, in five experiments 0.38 part being sufficient. In eight of the experiments, however, the maximum amount of disinfectant used was not sufficient to reduce the body temperature counts sufficiently to fall within the entire 100–10–5 standard. In two experiments 2.63 parts available chlorine were required to reduce the bacteria within the limits of the 1,000–100–50 standard, or to the limits of a moderately polluted water, and in one experiment 1.13 parts available chlorine were required to produce an effluent of the 10,000–1,000–500 quality.

Contact Filter Effluents.

The effluents from five different contact filters were studied, two experiments being made with each. The initial numbers of bacteria in these samples ranged from 257,000 to 1,200,000 per cubic centimeter. In eight experiments 0.38 part available chlorine produced a reduction in bacteria of 75 to 90 per cent., and in the other two experiments about 0.75 part chlorine was required to reduce the bacteria to the same extent. In seven of the experiments a reduction of 99 per cent. was accomplished by the use of 0.38 part, in two experiments by the use of 0.75 part, while in one experiment 1.13 parts were required to produce a similar reduction. Considering these results from the viewpoint of standards, in only one experiment was a sterile effluent produced by the use of the maximum amount of chlorine, 3.75 parts per 100,000, and in only this single experiment were the bacteria reduced within the 100–10–5 or water standard. In five experiments the bacteria were reduced to the 1,000–100–50 standard by the use of 0.38 part available chlorine, while in one experiment 2.25 parts were required to reduce the bacteria to this standard, and in another experiment 1.13 parts available chlorine were required to reduce the bactéria within the very polluted or 10,000–1,000–500 standard.

Trickling Filter Effluents.

Ten experiments were made with untreated trickling filter effluents, and two experiments with trickling filter effluents from which most of the suspended matters had been removed by settling. The initial numbers of bacteria in these samples ranged from 14,000 to 475,000 per cubic centimeter. These effluents differed from the sewages and contact filter effluents in being generally more completely oxidized and thus absorbing less of the hypochlorite before the disinfection should begin. In all of these experiments a reduction of 90 per cent. of the bacteria was produced by 0.38 part available chlorine or less, while in nine of the twelve experiments the same amount of disinfectant caused a reduction of over 99 per cent. in the bacterial content, and in the other three experiments a like reduction was produced by the use of 0.75 part per 100,000. In only one of these experiments, however, was a sterile effluent produced, and in five out of the twelve experiments the numbers of bacteria were not reduced within the 100–10–5 standard by the use of the maximum amount of disinfectant, 3.75 parts available chlorine per 100,000. In seven of the experiments 0.38 part chlorine was effective in reducing the bacteria to a standard 1,000–100–50, in one case, however, 1.88 parts chlorine being necessary to bring the samples down to this standard. In only one sample was 0.38 part chlorine insufficient to produce a bacterial reduction to the 10,000–1,000–500 standard, and in this case the next largest amount of disinfectant tried, 0.75 part chlorine per 100,000, proved effective.

Sand Filter Effluents.

Seven experiments were made with effluents from sand filters. These effluents were all clear and free from suspended matters, and the organic matters had been practically all oxidized, conditions being particularly favorable for disinfection treatment. The initial numbers of bacteria in these samples ranged from 36 per cubic centimeter to 35,000 per cubic centimeter. In two of the experiments, 0.75 part available chlorine was necessary to produce a bacterial reduction of 75 per cent.; in one experiment 1.13 parts chlorine were required to produce a reduction of 90 per cent., and in another experiment 3.75 parts available chlorine were required to produce a bacterial reduction of 99 per cent. In two of the seven experiments a completely sterile effluent was produced by the use of 0.38 part chlorine, and in one other experiment a sterile result was obtained by the use of 0.75 part chlorine, while in one experiment 3.38 parts were required to produce a like result, and in one other experiment a sterile effluent was not produced by the maximum amount of disinfectant used, 3.75 parts available chlorine per 100,000. Two of the samples were already within the standard of 100–10–5 before adding disinfectant, and three others were brought within this standard by the use of 0.38 part chlorine, the smallest amount used. Of the other two samples, one required 0.75 part and one required 1.88 parts available chlorine per 100,000 to reduce the bacteria within the limits of this standard. All of these samples, which were not already within the limits of the 1,000–100–50 standard were brought within that standard by the use of 0.38 part available chlorine per 100,000.

In all of these experiments it was to be noted that while a very great reduction in the room temperature counts was obtained by relatively small amounts of disinfectant, a very much larger amount of disinfectant was necessary to produce a corresponding reduction in the types of bacteria growing at body temperature. This will be noted in the tables in the different amounts of hypochlorites required to reduce the room temperature and body temperature counts to definite natural water standards. The significance of this will be discussed later.

The initial numbers of bacteria, and the amounts of available chlorine required to cause bacterial reductions of 75, 90 and 99 per cent., respectively, and the amounts required to bring the bacterial content of the various samples within the limits of the different arbitrary standards, are shown in the accompanying tables.

Initial Numbers of Bacteria before Disinfection.

Raw and Clarified Sewages.

SAMPLE.	BACTERIA PER CUBIC CENTIMETER.		
	20° C.	40° C.	
		Total.	Red.
Regular sewage,	1,100,000	112,500	95,000
Regular sewage,	1,300,000	185,000	175,000
Andover regular sewage,	735,000	175,000	110,000
Andover regular sewage,	1,155,000	280,000	200,000
Settled sewage,	895,000	140,000	95,000
Settled sewage,	2,340,000	207,500	180,000
Settled sewage,	1,200,000	505,000	482,000
Andover settled sewage,	1,800,000	450,000	405,000
Andover settled sewage,	1,185,000	430,000	387,000
Effluent, Strainer E,	910,000	117,500	82,500
Effluent, Strainer E,	1,275,000	212,000	197,000
Septic sewage,	2,000,000	250,000	230,000
Septic sewage,	780,000	177,500	160,000
Septic sewage,	1,115,000	192,000	165,000
Contact Filter Effluents.			
Filter No. 175,	1,200,000	195,000	97,500
Filter No. 175,	550,000	77,500	65,000
Filter No. 176,	293,000	112,000	77,500
Filter No. 176,	557,000	117,000	55,000
Filter No. 221,	1,090,000	275,000	120,000
Filter No. 221,	875,000	200,000	175,000
Filter No. 251,	885,000	103,000	102,000
Filter No. 251,	340,000	72,500	65,000
Filter No. 237,	390,000	33,800	24,500
Filter No. 237,	257,300	60,300	51,800

Initial Numbers of Bacteria before Disinfection — Concluded.

Trickling Filter Effluents.

Sample.	Bacteria per Cubic Centimeter.		
	20° C.	40° C.	
		Total.	Red.
Filter No. 135,	62,400	11,200	9,900
Filter No. 135,	14,200	3,200	2,500
Filter No. 136,	200,000	65,500	54,500
Filter No. 136,	73,800	8,000	5,900
Filter No. 222,	54,000	5,000	4,000
Filter No. 222,	475,000	72,500	55,000
Filter No. 235,	267,500	49,000	43,800
Filter No. 235,	245,000	123,500	115,000
Filter No. 247,	475,000	60,000	55,000
Filter No. 247,	280,000	49,300	44,800
Settled effluents, Nos. 135 and 136,	191,000	2,300	1,150
Settled effluents, Nos. 135 and 136,	82,500	9,900	6,000

Sand Filter Effluents.

Filter No. 4,	36	4	2
Filter No. 4,	52	1	1
Filter No. 6,	2,200	1,875	1,550
Filter No. 6,	475	78	12
Filter No. 250,	35,000	1,775	900
Filter No. 250,	2,850	32	2
Filter No. 315,	60	13	9

Amounts of Effective Chlorine required to reduce Bacterial Content to Prescribed Standards.

Raw and Clarified Sewages.

[Less than stated amount indicated by minus sign; more than stated amount indicated by plus sign.]

[Parts per 100,000.]

SAMPLE.	Sterile.	100-10-5 STANDARD.			1,000-100-50 STANDARD.			10,000-1,000-500 STANDARD.		
		20° C. 100.	40° C.		20° C. 1,000.	40° C.		20° C. 10,000.	40° C.	
			Total 10.	Red 5.		Total 100.	Red 50.		Total 1,000.	Red 500.
Regular sewage,	+3.75	1.13	+3.75	+3.75	0.75	1.13	1.13	0.75	0.38	0.38
Regular sewage,	+3.75	1.88	+3.75	+3.75	1.13	1.13	1.13	1.13	0.75	0.75
Andover regular sewage,	2.63	0.38	0.75	0.38	−0.38	0.38	−0.38	−0.38	−0.38	−0.38
Andover regular sewage,	+3.75	0.38	0.75	0.75	−0.38	0.38	0.38	−0.38	−0.38	−0.38
Settled sewage,	+3.75	0.75	+3.75	0.75	0.75	2.63	0.75	0.75	0.75	0.75
Settled sewage,	+3.75	1.88	+3.75	+3.75	1.50	1.88	1.13	1.50	1.13	1.13
Settled sewage,	+3.75	0.75	+3.75	+3.75	0.75	1.88	2.63	0.75	0.75	0.75
Andover settled sewage,	+3.75	0.38	1.50	1.50	−0.38	0.38	0.38	−0.38	−0.38	−0.38
Andover settled sewage,	+3.75	0.75	1.88	0.75	0.75	0.75	0.75	0.38	0.38	0.38
Effluent, Strainer E,	+3.75	0.75	3.38	3.38	0.38	0.75	0.75	−0.38	0.38	0.38
Effluent, Strainer E,	+3.75	0.38	3.75	+3.75	−0.38	0.38	0.75	−0.38	−0.38	0.38
Septic sewage,	+3.75	1.13	+3.75	+3.75	0.75	1.13	1.13	0.75	0.75	0.75
Septic sewage,	+3.75	1.13	+3.75	+3.75	0.75	0.75	0.75	0.75	0.75	0.75
Septic sewage,	+3.75	0.38	+3.75	3.75	−0.38	0.75	0.38	−0.38	0.38	−0.38
Contact Filter Effluents.										
Filter No. 175,	+3.75	0.38	+3.75	1.88	−0.38	0.38	0.38	−0.38	−0.38	−0.38
Filter No. 175,	+3.75	0.38	+3.75	+3.75	−0.38	0.38	0.38	−0.38	−0.38	−0.38
Filter No. 176,	+3.75	1.88	+3.75	1.13	1.13	1.13	1.13	0.75	1.13	1.13
Filter No. 176,	+3.75	1.50	+3.75	3.00	1.13	2.25	0.75	0.75	0.75	0.75
Filter No. 221,	+3.75	0.75	+3.75	+3.75	0.75	0.75	0.75	0.75	0.75	0.38
Filter No. 221,	+3.75	0.38	+3.75	1.13	−0.38	0.38	0.38	−0.38	−0.38	−0.38
Filter No. 251,	+3.75	0.38	+3.75	2.63	−0.38	0.38	0.38	−0.38	−0.38	−0.38
Filter No. 251,	+3.75	0.38	+3.75	3.38	−0.38	0.75	0.75	−0.38	0.38	0.38
Filter No. 237,	+3.75	0.38	+3.75	+3.75	−0.38	0.38	0.75	−0.38	−0.38	0.38
Filter No. 237,	3.75	0.38	3.00	1.13	−0.38	0.38	0.38	−0.38	−0.38	−0.38

Amounts of Effective Chlorine required to reduce Bacterial Content to Prescribed Standards — Concluded.

Trickling Filter Effluents.

[Parts per 100,000.]

SAMPLE.	Sterile.	100-10-5 STANDARD.			1,000-100-50 STANDARD.			10,000-1,000-500 STANDARD.		
		20° C. 100.	40° C.		20° C. 1,000.	40° C.		20° C. 10,000.	40° C.	
			Total 10.	Red 5.		Total 100.	Red 50.		Total 1,000.	Red 500.
Filter No. 135, . . .	+3.75	0.38	+3.75	2.63	—0.38	0.38	—0.38	—0.38	—0.38	—0.38
Filter No. 135, . . .	+3.75	0.38	0.75	0.38	—0.38	0.38	—0.38	—0.38	—0.38	—0.38
Filter No. 136, . . .	+3.75	0.38	+3.75	3.00	—0.38	0.38	0.38	—0.38	—0.38	—0.38
Filter No. 136, . . .	+3.75	0.38	3.38	2.25	—0.38	0.75	0.38	—0.38	0.38	—0.38
Filter No. 222, . . .	3.75	0.75	1.13	1.13	0.38	0.38	0.38	—0.38	—0.38	—0.38
Filter No. 222, . . .	+3.75	3.38	+3.75	3.38	0.75	1.88	0.75	0.38	0.75	0.75
Filter No. 235, . . .	+3.75	0.38	+3.75	—0.38	0.38	0.38	—0.38	—0.38	—0.38	—0.38
Filter No. 235, . . .	+3.75	—0.38	0.38	1.50	—0.38	—0.38	0.38	—0.38	—0.38	—0.38
Filter No. 247, . . .	+3.75	0.38	+3.75	3.38	0.75	—0.38	0.38	0.38	—0.38	—0.38
Filter No. 247, . . .	+3.75	0.75	+3.75	1.13	0.38	0.75	0.38	—0.38	0.38	—0.38
Settled effluents, . .	+3.75	0.38	3.75	3.38	—0.38	0.38	0.38	—0.38	—0.38	—0.38
Filters Nos. 135 and 136, .	+3.75	0.38	0.38	1.88	—0.38	—0.38	0.38	—0.38	—0.38	—0.38

Sand Filter Effluents.

Filter No. 4, ...	0.38	—[1]	—[1]	—[1]	—[1]	—[1]	—[1]	—[1]	—[1]	—[1]
Filter No. 4, ...	0.38	—[1]	—[1]	—[1]	—[1]	—[1]	—[1]	—[1]	—[1]	—[1]
Filter No. 6, ...	1.13	0.38	0.75	0.75	—0.38	0.38	0.38	—[1]	—0.38	—0.38
Filter No. 6, ...	0.75	—0.38	0.38	0.38	—[1]	—[1]	—[1]	—[1]	—[1]	—[1]
Filter No. 250, . . .	2.25	0.38	1.88	1.88	—0.38	0.38	0.38	—[1]	—0.38	—0.38
Filter No. 250, . . .	3.38	0.38	0.38	—[1]	—0.38	—[1]	—[1]	—[1]	—[1]	—[1]
Filter No. 315, . . .	+3.75	—[1]	0.38	—0.38	—[1]	—[1]	—[1]	—[1]	—[1]	—[1]

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[1] Initial number of bacteria less than standard.

Amount of Effective Chlorine required to produce Stated Reductions in Numbers of Bacteria.

Raw and Clarified Sewages.

[Less than stated amount indicated by minus sign; more than stated amount indicated by plus sign.]

[Parts per 100,000.]

SAMPLE.	75 PER CENT REDUCTION.			90 PER CENT. REDUCTION.			99 PER CENT. REDUCTION.		
	20° C.	40° C.		20° C.	40° C.		20° C.	40° C.	
		Total.	Red.		Total.	Red.		Total.	Red.
Regular sewage,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.75	0.38	0.38
Regular sewage,	0.75	0.75	0.75	0.75	0.75	0.75	1.13	0.75	0.75
Andover regular sewage,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	—0.38	0.38
Andover regular sewage,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	0.38
Settled sewage,	—0.38	—0.38	0.38	0.38	—0.38	0.38	0.75	0.38	0.75
Settled sewage,	0.75	0.75	0.75	0.75	0.75	0.75	1.13	1.13	1.13
Settled sewage,	—0.38	—0.38	—0.38	0.38	—0.38	0.38	0.75	0.38	0.75
Andover settled sewage,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	0.38
Andover settled sewage,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	0.38
Effluent, Strainer E,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	0.38
Effluent, Strainer E,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38
Septic sewage,	—0.38	0.75	0.75	0.38	0.75	0.75	0.75	0.75	0.75
Septic sewage,	0.38	0.38	0.38	—0.75	0.75	0.75	0.75	0.75	0.75
Septic sewage,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38
Contact Filter Effluents.									
Filter No. 175,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	0.38
Filter No. 175,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	—0.38
Filter No. 176,	0.75	0.38	0.75	0.75	0.75	0.75	1.13	1.13	0.75
Filter No. 176,	0.75	—0.38	0.38	0.75	0.38	0.38	0.75	0.75	0.75
Filter No. 221,	—0.38	—0.38	—0.38	0.38	—0.38	—0.38	0.75	0.38	0.38
Filter No. 221,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	—0.38
Filter No. 251,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	—0.38
Filter No. 251,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	—0.38
Filter No. 237,	—0.38	—0.38	—0 38	—0.38	—0.38	—0.38	0.38	0.38	—0.38
Filter No. 237,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	—0.38

Amount of Effective Chlorine required to produce Stated Reductions in Numbers of Bacteria — Concluded.

Trickling Filter Effluents.

[Parts per 100,000.]

Sample.	75 Per Cent. Reduction.			90 Per Cent. Reduction.			99 Per Cent. Reduction.		
	20° C.	40° C.		20° C.	40° C.		20° C.	40° C.	
		Total.	Red.		Total.	Red.		Total.	Red.
Filter No. 135,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	0.38
Filter No. 135,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.75	0.75	—0.38
Filter No. 136,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	—0.38
Filter No. 136,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.75	—0.38
Filter No. 222,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	0.38
Filter No. 222,	—0.38	—0.38	—0.38	—0.38	0.38	0.38	0.38	0.75	0.75
Filter No. 235,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	0.38
Filter No. 235,	—0.38	—0.38	—0.33	—0.38	—0.38	—0.38	0.38	0.38	—0.38
Filter No. 247,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	—0.38
Filter No. 247,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	—0.38
Settled effluents,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	—0.38
Filters Nos. 135 and 136,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.38	—0.38
Sand Filter Effluents.									
Filter No. 4,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38
Filter No. 4,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38
Filter No. 6,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.75	0.38
Filter No. 6,	—0.38	—0.38	—0.38	—0.38	—0.38	—0.38	0.38	0.75	—0.38
Filter No. 250,	—0.38	—0.38	—0.38	—0.38	0.38	0.38	0.38	0.75	0.75
Filter No. 250,	—0.38	0.75	—0.38	—0.38	0.75	—0.38	0.38	0.75	—0.38
Filter No. 315,	—0.38	0.75	—0.38	1.13	0.75	0.38	3.75	1.13	0.75

DISINFECTION OF ENTIRE VOLUMES OF SEWAGE APPLIED TO FILTERS NOS. 10 AND 248, AND OF THE ENTIRE EFFLUENTS FROM TRICKLING FILTERS NOS. 135 AND 136.

During the summer of 1908 studies were made to test under average working conditions the practical application of hypochlorite disinfection upon somewhat larger volumes of sewages, etc., than were used in the laboratory experiments. In these experiments the entire volumes of sewage applied to each of two of the experimental filters, and the entire combined volumes of effluent from two trickling filters were treated with disinfectant each day during a period of some months.

From August 3 to November 2, inclusive, all of the regular sewage applied to Filter No. 10 was treated with calcium hypochlorite. This sewage, 250 gallons per day, was pumped in the late afternoon, disinfectant equivalent to 2.5 parts per 100,000 available chlorine was added, and the contents of tank thoroughly mixed. The sewage was then allowed to stand over night, twelve to fourteen hours, when it was again thoroughly mixed, samples were collected and it was applied to the filter. The removal of the various types of bacteria varied from less than 20 per cent. to over 99 per cent. on different days, the average removal of total bacteria being about 90 per cent. and the average removal of types growing at body temperature being 97 per cent. About 22 per cent. of the samples of disinfected sewage collected during the three months the experiment was continued showed bacterial counts within the drinking water, or 100–10–5 standard, and about 44 per cent. of such samples were within the limits of the 1,000–100–50 standard. Over one-half of the samples of disinfected sewage, however, contained numbers of bacteria which were in excess of the 10,000–1,000–500 standard.

From April 3 to October 31 the settled sewage applied to trickling Filter No. 248 was treated with calcium hypochlorite. The entire supply of sewage for this filter, 100 gallons per day, was pumped each morning into a feed tank from which it was slowly applied to the filter during the day. Immediately after pumping the disinfectant was added to the sewage and the entire contents of the feed tank were thoroughly mixed, after which the flooding of the filter was commenced. By this procedure some portions of the sewage reached the filter in the morning immediately after the addition of the disinfectant, while the sewage applied in the late afternoon had received a number of hours' storage since disinfection. Routine daily samples of this sewage were collected four to six hours after disinfection, and in addition a number of series of samples were collected at hourly intervals while the experiment was in progress. At first, disinfectant equivalent to only 0.5 part per 100,000 available chlorine was added. This amount was gradually increased until. from June 1 to July 11, 2.5 parts available chlorine were being added. From July 12 to August 2 hypochlorite equivalent to 3.75 parts available chlorine was added, and from August 3 to October 31, inclusive, the amount of disinfectant added was equivalent to 5.0 parts available chlorine per 100,000. During the period when the amount of hypochlorite added was less than the equivalent of 3.75 parts per 100,000 available chlorine, the results of disinfection were far from satisfactory. The average removal of total bacteria was about 12 per cent. during the period when disinfectant equivalent to 0.5 part available chlorine was used, and about 80 per cent. or less when the available chlorine added was equivalent to 1.0 part, 1.5 part and 2.5 parts, respectively, and the average removal of the types of bacteria developing at body temperature during these periods did not exceed about 90 per cent. During the last two periods, when disinfectant equivalent to 3.75 parts and 5.0 parts available chlorine, respectively, was being used, the removal of all types of bacteria averaged over 99 per cent., and the disinfected effluent was of reasonably satisfactory quality. Of the samples collected during the period when hypochlorites equivalent to 3.75 parts per 100,000 available chlorine were added, about 80 per cent. showed room temperature counts less than 100 bacteria per cubic centimeter, while about 5 per cent. showed over 1,000 bacteria per cubic centimeter. Taking the body temperature counts into consideration, however, the results were far less satisfactory, only about one-fifth of the samples conforming to the drinking water, or 100–10–5 standard, and a majority of the samples showing body temperature counts which were as high as those commonly obtained with the very polluted Merrimack River water. During the latter period, when disinfectant equivalent to 5.0 parts per 100,000 available chlorine was added, none of the samples showed more than 100 bacteria per cubic centimeter by the room temperature count, and more than one-third of the samples showed counts at body temperature sufficiently low to permit the samples to be included under the drinking water standard. During the preceding period, however, the disinfection process was far less effective in destroying the types of bacteria growing at body temperature than the types determined by the usual room temperature plates; in fact, in a majority of the samples collected during these last two periods the body temperature counts were many times as great as the room temperature counts.

The results obtained in the various series of samples which were collected at hourly intervals were similar to those which were obtained in the bottle experiments previously discussed. The series show that the routine samples which were collected four to six hours after disinfection were fairly representative of the sewage as it flowed to the filter throughout the twenty-four hours. The general effect of the time factor in disinfection will be discussed later.

From August 3 to November 2, inclusive, the combined effluents from trickling Filters Nos. 135 and 136 were treated with hypochlorite of lime in the proportion of 2.5 parts per 100,000 available chlorine. These combined effluents, after treatment, flowed into a settling tank in which they received about four hours' sedimentation and storage, and from which they were pumped at intervals for flooding various secondary filters. The total volume of effluents disinfected in this manner averaged about 200 gallons per day. The average reductions of bacteria of all types by the process was over 99 per cent., the average number of bacteria determined by room temperature counts being 8 per cubic centimeter, and the average number of bacteria growing at body temperature being 24 per cubic centimeter, of which 2 per cubic centimeter on the average were acid-producing types. On only one sample of the disinfected effluents collected during this period did the numbers of bacteria determined at 20° C. exceed 100 per cubic centimeter, and in over one-half of the samples, plates at this temperature showed no colonies whatever. The reduction of the types of bacteria growing at body temperature, however, was not proportionate to the reduction in the room counts except in the case of a very few samples. In fact, owing to these high body temperature counts less than one-fifth of the samples would conform to the drinking water, or 100–10–5 standard, quality.

Average Results of Disinfection of Entire Volumes of Sewage applied to Filters Nos. 10 and 248, and of the Entire Effluents from Trickling Filters Nos. 135 and 136.

Regular Sewage for Filter No. 10.

1908.	Amount of Disinfectant. Available Chlorine per 100,000.	BACTERIA PER CUBIC CENTIMETER.						PER CENT. OF BACTERIA REMOVED.		
		BEFORE DISINFECTION.			AFTER DISINFECTION.					
		20° C.	40° C.		20° C.	40°C.		20°C.	40° C.	
			Total.	Red.		Total.	Red.		Total.	Red.
August 3–November 2,	2.50	1,610,000	448,000	355,000	162,000	14,200	12,500	90	97	97

Settled Sewage for Filter No. 248.

April 3–13, . . .	0.50	1,430,000	172,000	135,000	1,260,000	103,000	85,200	12	40	37
April 14–26, . . .	1.00	1,660,000	113,000	101,000	320,000	43,800	31,800	81	61	68
April 27–May 31, .	1.50	882,000	244,000	120,000	250,000	38,500	34,000	72	84	72
June 1–July 11, . .	2.50	714,000	264,000	216,000	161,900	29,800	15,800	77	89	93
July 12–August 2, .	3.75	811,000	295,000	237,000	1,710	40	3	99+	99+	99+
August 3–November 1,	5.00	1,330,000	205,000	169,000	4	21	2	99+	99+	99+

Combined Effluents from Trickling Filters Nos. 135 and 136.

August 3–November 2,	2.50	26,000	6,200	4,400	8	24	2	99+	99+	99+

EFFECT OF TIME OF STORAGE UPON EFFICIENCY OF HYPOCHLORITE DISINFECTION.

In the laboratory experiments, analyses of all samples were made at intervals of one, two, four, six and twenty-four hours after the disinfectant was added, and in the experiments in which the entire volume of settled sewage applied to Filter No. 248 was treated daily with hypochlorites many series of hourly samples were collected of the disinfected sewage as it flowed upon the filter. While there is some disagreement in the results of the various experiments, it is possible to determine approximately the relative amounts of disinfectant which would be required to yield similar results with different storage periods. In all cases the greater portion of the work of disinfection occurred during the first hour, after which the elimination of bacteria continued more slowly for some hours. This is especially noticeable in those cases where relatively small amounts of disinfectants were used. A general average of all the results show the effect of storage to be about as follows: with two hours' storage about 84 per cent. as much hypochlorite was required to produce the same result as with a storage of one hour; with four hours' storage about 82 per cent. as much hypochlorite was required; with six hours' storage about 77 per cent. as much hypochlorite was required, and with twenty-four hours' storage about 61 per cent. as much hypochlorite was required to produce the same result as with a storage of one hour.

THE APPARENT SELECTIVE ACTION OF HYPOCHLORITES AND OTHER OXIDIZING DISINFECTANTS.

The results of all the experiments on disinfection of water and sewage show that the disinfectants of the oxidizing type apparently exert a selective action on different types of bacteria. It has already been noted that although an effluent of about the same bacterial quality as many good municipal water supplies might be obtained by the use of a certain amount of hypochlorites when the results of disinfection were judged solely by room temperature counts, a much larger amount of disinfectant is required to produce an effluent of the same standard if body temperature counts are taken into consideration. A similar selective action has also been noticed with other oxidizing disinfectants, such as permanganates and peroxides. It has not been evident, however, when the metallic salts or organic antiseptics have been employed. Considerable study has been given to this phenomenon of abnormally high body temperature counts in waters and sewages which have been treated with disinfectants, and their significance in water purification was discussed at some length in the reports for the years 1908 and 1909.

The difference in the significance of the counts of bacteria made at the two temperatures is becoming much better understood as the making of routine counts at both temperatures has become more general. The room temperature count includes many types of bacteria whose numbers are subject to fluctuations which have no sanitary significance. This count has until within a very few years been used practically alone for stating the bacterial content of natural waters and sewages. The body temperature counts, on the other hand, while much smaller than the room temperature counts, show more closely the numbers of bacteria present which are of the types of fecal origin and therefore of sanitary significance. Moreover, in natural waters and sewages under ordinary conditions there is an approximately definite ratio between the counts obtained at the two temperatures, and while higher counts at body temperature than at room temperature are not unknown they are of relatively rare occurrence. In both waters and sewages which have been treated with disinfectants of the oxidizing type, however, relatively high counts at body temperature and much smaller counts at room temperature in the same sample are of frequent occurrence, and much larger quantities of these disinfectants are required to eliminate the types of bacteria shown by the body temperature counts than are required to cause a corresponding reduction in the great mass of ordinary bacteria which appear on the room temperature plates. Such results cannot but indicate that the oxidizing disinfectants and particularly the hypochlorites are selective in their action, and are least efficient in destroying certain types of bacteria which show up on the body temperature plates but fail to develop on room temperature plates. These types are not of the usual colon type, as is evident by the small proportion of red colonies on the body temperature plates. Furthermore, these resistant types are not, in the majority of instances, spore-forming bacteria, although a small proportion of spore formers is found among them. During recent years considerable emphasis has been laid upon the results of tests for B. coli in interpreting the analysis of water. This emphasis is well grounded, and tests for B. coli are undoubtedly a valuable part of sanitary water analysis, but it must be borne in mind that the B. coli test as at present applied in the majority of laboratories is a test only for the presence of a certain group of fecal bacteria, and that there are other types of fecal bacteria which are fully as numerous and which may and probably do have as much or more sanitary significance than the types included under the usual B. coli tests. In the analysis of natural waters perhaps the omission to look for these types may not be of great practical importance, since the bacterial tests are usually supplemented by chemical analyses and by rigid inspection of the sources. In the disinfection of waters and sewages, however, reliance must be placed entirely upon the bacteriological tests, and if any of the types of bacteria included within the great fecal group are less amenable to disinfection than are the vast majority, that fact is of the utmost significance and should be given all due prominence.

INCREASE IN BACTERIA AFTER DISINFECTION WITH HYPOCHLORITES.

In the discussion of the results of experiments on disinfection of water on page 329 of the report for 1909, attention was called to the fact that large secondary growths of bacteria may occur rapidly in waters which have been treated with hypochlorites. Similar phenomena have been noted in the experiments on disinfection of sewages and sewage effluents. In a considerable number of the bottle experiments it was found that while the bacteria had been reduced to very small numbers when the samples were examined at the end of two to four hours, examinations made at the end of twenty-four hours showed that a very large secondary increase had taken place in the bacterial content of the samples. The relative occurrence of these after-growths in the various classes of samples, and the largest amount of disinfectant in each experiment which failed to prevent such growths, are shown in the following table: —

	Number of Experiments made.	NUMBER OF EXPERIMENTS. INCREASE NOTED.			LARGEST AMOUNT OF HYPOCHLORITE IN EACH EXPERIMENT WHICH FAILED TO PREVENT BACTERIAL INCREASE (PARTS PER 100,000).		
		20° C.	40° C.		20° C.	40° C.	
			Total.	Red.		Total.	Red.
Raw sewage, . .	4	1	1	2	0.75	0.38	0.38, 0.75
Clarified sewage, .	10	5	5	7	0.38 0.75[3] 1.50	0.38[1] 1.13	0.38[2] 1.13
Contact filters, . .	10	2	2	4	1.50 1.88	0.38 0.75	0.38[4] 0.75[4]
Trickling filters, . .	12	3	2	2	0.75[4] 1.13	0.38 0.75	0.38 1.13
Sand filters, . .	7	0	0	0	-	-	-

[1] Four experiments. [2] Six experiments. [3] Three experiments. [4] Two experiments.

It will be noted that bacterial multiplication after disinfection was only observed in part of the experiments, and that it was not observed at all in the experiments with effluents from sand filters. The reason for this will be apparent when the reason for secondary bacterial growths is made clear. The power of the hypochlorites as disinfectants lies in their property of liberating oxygen which may act upon the bacteria, or which may be absorbed wholly or in part by any other oxygen-absorbing substance with which it comes in contact. When once the oxygen is all absorbed the disinfecting value of the hypochlorites is exhausted. The sewages and effluents from contact and trickling filters contain substances which have greater or less affinity for this oxygen, so that only a part of the hypochlorite oxygen is available for destroying the bacteria. If, then, such an amount of hypochlorites be added that all the oxygen is completely absorbed before complete disinfection has occurred, the remaining bacteria may multiply without restraint. In fact, through the elimination of a large proportion of the bacteria, including probably the entire numbers of certain species, the conditions have been made peculiarly favorable for rapid multiplication of those bacteria which remain, since bacterial equilibrium has been destroyed, natural bacterial antagonism has been to a greater or less extent eliminated, and, certain portions of the organic matters having been oxidized, the dissolved matters may perhaps have become better suited for bacterial food than previously. These are the conditions which probably were obtained in the experiments noted in the table above. In every case practically all of the bacteria were destroyed, but a few were left which, the disinfectant being all exhausted, found themselves in a peculiarly favorable environment. That they multiplied under these conditions from 100 to 1,000 times their original numbers is in accord with the usual multiplication of bacteria under other favorable conditions. That no such after-growths were observed in the case of sand filter effluents is explained, when we consider that these sand filter effluents were all highly oxidized and probably did not absorb the oxygen from the disinfectant, so that the smallest amount of hypochlorites used in the experiments made with them, 0.38 part per 100,000, was sufficient not only to destroy practically all the bacteria, but to leave some traces of disinfectant still in solution by which the germinating bacteria were destroyed and after-growths prevented. Had tests been made on these effluents with smaller quantities of hypochlorites it is very probable that after-growths of bacteria would have been observed, as, in fact, such growths have been frequently observed in water under similar conditions.

The occurrence of these after-growths introduces the very interesting and important question as to their possible sanitary significance. From the results of the experiments shown in the table above it is evident that not only were after-growths found in the types of bacteria usually determined on room temperature plates, but they were also observed in the types determined on the body temperature plates, and were particularly prevalent in the acid-producing types developing on plates at the higher temperature. Since the body temperature counts undoubtedly indicate the possible presence of disease-producing germs of intestinal origin more clearly than do the room temperature counts, and since a considerable proportion of the bacteria appearing as red colonies on the plates at the higher temperature when dealing with natural waters and sewage are of, or akin to, the colon type, which type has been used for some years as an index of possible danger, the occurrence of after-growths of these types is highly significant, and raises the question whether multiplication of disease-producing organisms might not possibly occur under similar conditions in disinfection practice. This question cannot be satisfactorily answered until a more extended study has been made of the species of bacteria which appear in these after-growths and a careful study of the behavior of various pathogenic bacteria under similar conditions. The conditions implied are such as might readily be obtained with greater or less frequency in the practical disinfection of sewage and sewage effluents on a large scale, although they would be less likely to occur in disinfection of stools and other infected material in which an excess of disinfectants are usually employed and from which our present knowledge of the resistance of pathogenic bacteria to various disinfectants has been largely drawn.

Another question which arises is, if a rapid multiplication of the bacteria remaining after treatment with a disinfectant is possible under certain conditions, would a similar multiplication occur if the disinfected sewage were diluted with natural water, as for example, when such a sewage were turned into a river? In this case bacterial multiplication would undoubtedly be influenced both by the amount of dilution which the disinfected sewage received and by the numbers of bacteria in the water used for dilution. Studies of this phase of the problem are now in progress at the experiment station. In these studies samples of sewage have been treated with amounts of hypochlorite of lime sufficient to reduce the bacteria to very low numbers, but not sufficient to produce complete sterilization. After the disinfectant has been allowed to act for a period of two hours the samples have been diluted with various proportions of natural water, and analyses of a sample of the water used for dilution, of the undiluted sewage, and of the various mixtures of the two have been made at intervals for a number of days. At the present time these studies are far from complete, but the results so far obtained indicate that there may be a rapid increase in the numbers of bacteria after partial disinfection and subsequent dilution, this increase being much greater in the mixtures of sewage and water than in either the sewage or the water used for dilution alone. This is particularly noticeable in the total and red colony counts on the body temperature plates.

Ordinarily there is little or no increase in these counts on samples of water or sewage on standing, and this has been true of the samples of the water used for dilution. In the disinfected sewage and in the mixtures of disinfected sewage and water, however, there has always been a large increase in these counts on standing, in some cases the numbers of these types of bacteria increasing many thousandfold in the course of a few days. It would appear from these results that the exterior of certain particles of organic matter was seared by the disinfectant and the bacteria killed, but the bacteria within the particles left unharmed. So far experiments have only been made with disinfected settled sewage diluted with tap water, and it is impossible to predict what results may be obtained when other sewages, or effluents from sewage filters, are diluted with waters containing larger initial numbers of bacteria. The problem is an important one, and fully merits thorough investigation before disinfection of sewage, etc., by hypochlorites comes into more general practice.

Estimation of Amount of Hypochlorites required for Disinfection from Oxygen consumed.

In his excellent book upon the purification of sewage, Rideal[1] states that the amount of chlorine necessary for disinfection may be closely estimated from the oxygen consumed from permanganate (five minutes). In the Lawrence experiments it was found that in about one-half of the samples of sewage and sewage effluents the amount of chlorine computed from the oxygen consumed, and the amount of chlorine required as shown by experiment, agreed with some degree of accuracy. In about one-fourth of the samples the computed amount of disinfectant was very much less than the amount which the experiments showed to be necessary to produce any practical effect, while in the remainder of the experiments the amount computed from the oxygen consumed was from two to ten times as much as was actually required to produce complete disinfection. Judging from these results, while the oxygen consumed values might furnish some idea as to the amount of disinfectant to be used, the possibility of error would be so large that little reliance could be placed upon this method of estimating the proportion of disinfectant required.

Cost of Hypochlorite Disinfection.

Commercial bleaching powder or calcium hypochlorite packed in sealed drums holding 700 to 800 pounds each, with a guaranteed strength of 36 to 38 per cent. available chlorine, may be purchased in carload lots for about 1¼ cents per pound. In smaller drums of 25 to 100 pounds each, bleach of the same strength costs about 2 to 3 cents a pound, depending upon the size of the shipment. Broken bulk bleaching powder costs 3 to 5 cents per pound in New England when obtained in small lots from a chemical stock-house. Commercial bleach loses strength rapidly up to a certain point when exposed to the air, and broken bulk purchases, or drum packages whose contents are not used at once after opening, will be found to contain less available chlorine. Analyses of a number of samples of broken bulk bleaching powder at the experiment station show that in many cases the strength may be less than 25 per cent. available chlorine. The cost of this disinfectant, therefore, depends largely upon the daily amount of hypochlorites required, the extremely large disinfecting plant having the advantage of low price on bleach of guaranteed strength, the full strength of which would be available through immediate use of the contents of the large drums shortly after they were opened. The plant treating a small volume of sewage daily would pay a higher price for smaller packages, or if buying in larger lots to obtain low first cost, would find the ultimate cost increased by loss of strength which the contents of these larger packages would suffer during the period before they were consumed. For the large plant, where large volumes of sewage were to be treated daily, the disinfection costs might be reduced somewhat by the use of sodium hypochlorite manufactured at the plant. Sodium hypochlorite is readily prepared by electrolysis of solutions of common salt. As it exists only in solutions its use has been limited owing to difficulty of transportation. As a disinfectant it is fully as efficient as bleaching powder, and where common salt can be cheaply obtained and the cost of electric power is low there is no reason why the installation of an electrolytic plant should not help to reduce disinfection costs when a large amount of disinfectant is required. For the small disinfection plant, however, the use of commercial bleaching powder would probably be the cheapest in the end. Another factor which enters into the cost of disinfection is the standard of quality required in the effluent from the disinfecting plant.

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[1] Rideal. Sewage and the Bacterial Purification of Sewage, Third Edition, 1906, p. 186.

Assuming a disinfectant containing 33⅓ per cent. available chlorine at a cost of 2 cents per pound, the treatment of a sewage with 0.1 part per 100,000 available chlorine would require 25 pounds of disinfectant at a cost for chemicals of 50 cents per million gallons. On this basis, using the proportions of disinfectant required as shown in the tabulated results of the experiments given on pages 347–350, inclusive, the cost of disinfecting the various kinds of sewage and sewage effluents to definite prescribed bacterial contents would be about as follows: —

To produce complete sterilization the cost would be well over $19 per million gallons for sewages and the effluents from contact and trickling filters, and would vary from $1.50 to over $19 for effluents from sand filters.

To produce a bacterial quality which would conform to the drinking water, or 100–10–5 standard, the cost would vary from $3.75 to over $19 per million gallons for raw sewage and effluents from trickling filters, from $7.50 to over $19 per million gallons for settled sewage, from $15 to $19 per million gallons for strained sewage and contact filter effluents, would be over $19 for septic sewage, and would vary between $1.75 and $9.50 per million gallons for the effluents from sand filters which were not originally of that quality.

To produce a bacterial quality to correspond to the 1,000–100–50 standard, or one which would be about equal to that of the better class of streams or rivers which are not seriously polluted, the cost would be from $1.75 to $5.60 per million gallons for raw sewage, from $1.75 to $13 for settled sewage, about $3.75 for strained sewage, between $3.75 and $5.60 for septic sewage, from $1.75 to $5.60 for effluents from contact filters, and from $1.75 to $3.75 for effluents from trickling filters. The cost of disinfecting sand filter effluents to produce this quality would not be over $1.75 per million gallons, judging from the experimental results.

If it was desired to reduce the bacterial content only to a point where they would approximately correspond with the more polluted rivers, or say within the 10,000–1,000–500 standard, the costs would be from $1.75 to $5.60 per million gallons for raw sewages and effluents from contact filters, between $1.75 and $7.50 for settled sewages, from $1.75 to $3.75 for septic sewage and effluents from trickling filters, and about $1.75 per million gallons for strained sewage.

These cost estimates are for chemicals only and do not include operating and sinking fund charges.

EXPERIMENTS WITH COPPER SULPHATE.

A number of experiments have been made at Lawrence to determine the disinfecting value of copper sulphate, which, before the hypochlorites came into use, was employed to a certain extent in water purification, and was advocated as a practical disinfectant for sewages and sewage effluents. These experiments showed that a reduction of 75 per cent. of the bacteria could be obtained in settled and strained sewages and in the effluents from contact filters by the use of 1 part copper sulphate per 100,000, and in raw sewages and effluents from trickling filters by the use of about 10 parts per 100,000. To obtain a reduction of 90 per cent. in the bacteria about 1.0 part per 100,000 was required for strained sewage and contact filter effluents, about 10 parts were required for raw and settled sewage, and about 100 parts for trickling filter effluents. To obtain a reduction of 99 per cent. or over in the bacterial content it was necessary to use copper sulphate in the proportion of about 10 parts per 100,000 for settled and strained sewages and for contact filter effluents, of about 100 parts for raw sewages, and about 1,000 parts per 100,000 for trickling filter effluents. In no case was a complete sterilization obtained on any of the samples of sewages or effluents tested by the use of 1,000 parts of copper sulphate per 100,000, and at least this amount was required to reduce the bacterial content of these samples to within the 1,000–100–50 standard. A reduction of the bacteria to the 10,000–1,000–500 standard was obtained by the use of about 10 parts of copper sulphate per 100,000 in the case of settled sewages and contact filter effluents, and by the use of about 100 parts per 100,000 in the case of raw sewages and trickling filter effluents. The results quoted are for a disinfection period of four to six hours. With the higher amounts used, the bacterial counts were still further reduced after more extended disinfection periods. With the smaller amounts, 10 parts per 100,000 in the case of raw sewage and 1 part per 100,000 in the case of other samples, while a substantial decrease in the bacteria occurred during the first six hours, analyses at the end of twenty-four hours usually showed that there had been a large secondary growth of the types of bacteria recorded on the room temperature plates.

At the present time copper sulphate can be bought in large lots at about 4¾ cents per pound. At this price the cost of treatment with 1.0 part per 100,000 copper sulphate would be about $3.95 per million gallons.

EXPERIMENTS WITH OTHER DISINFECTANTS.

Extensive studies have been made of the influence of many different substances having antiseptic properties upon the purification of sewage or manufacturing wastes in which those substances might be present. The results of these were summarized on pages 100 to 113, inclusive, of the report for 1908. Studies have also been reported upon the use of various antiseptics for the prevention of bacterial decomposition in samples of sewage, etc., between collection and analysis. In addition a few tests have been made of the disinfecting action of a number of substances upon sewage or sewage effluents, and while these substances, by reason of inefficiency or high cost, would probably never be used for practical treatment of sewage, nevertheless the results have a certain value and as such are worthy of being placed on record. The results of these tests may be briefly summarized as follows: —

Potassium Permanganate.

A reduction of 99 per cent. of all types of bacteria in trickling, contact and sand filter effluents was obtained by the action of 1 part per 100,000 potassium permanganate for six hours, and a similar reduction in sewage and settled sewage was obtained by the use of 10 parts per 100,000. Complete sterilization of a good sand filter effluent was obtained by the use of 1 part per 100,000, but complete sterilization of the sewages and other filter effluents was not accomplished by the use of 1,000 parts per 100,000, and, in fact, this concentration was necessary to reduce the bacterial contents of these types of samples to within the drinking water, or 100–10–5 standard. The bacterial content of the contact filter effluent was reduced to the 1,000–100–50 standard by the use of 10 parts per 100,000, but from 100 to 1,000 parts were required to produce this standard of quality in the sewages and the effluent from a trickling filter.

Hydrogen Peroxide.

Commercial hydrogen peroxide in the proportion of 100 parts per 100,000 produced complete sterilization of a trickling filter effluent in five hours. In the proportion of 10 parts per 100,000 a reduction of about 97 per cent. in the room temperature counts and about 82 per cent. in body temperature counts were obtained after five hours, and a reduction of over 99 per cent. of all types of bacteria was obtained after twenty-four hours.

Salicylic Acid.

Five hours after treatment of the effluent from a trickling filter with salicylic acid in the proportion of 10 parts per 100,000 no reduction was observed in the room temperature counts, but the body temperature counts had been reduced about 50 per cent. Twenty-four hours after treatment with the above concentration a reduction of about 80 per cent. was observed in room temperature counts and about 70 per cent. in body temperature counts. With a concentration of 100 parts per 100,000, five hours after treatment the reduction in all types of bacteria was over 99 per cent. This concentration was not sufficient, however, even after twenty-four hours, to effectually reduce the bacteria within the 1,000–100–50 standard.

Benzoic Acid.

When added to the effluent from a contact filter in the proportion of 10 parts per 100,000, benzoic acid produced no effect upon the bacteria in twenty-four hours. A concentration of 100 parts per 100,000 caused a reduction of about 76 per cent. in the room temperature counts and about 97 per cent. in the body temperature counts in five hours, and a practically complete sterilization in twenty-four hours.

Sodium Benzoate.

When added to effluents from contact and trickling filters in the proportion of 10 parts and 100 parts per 100,000, sodium benzoate produced no reduction in bacteria in six hours. In concentrations of 100 to 1,000 parts per 100,000, 70 to 80 per cent. reductions in the room temperature counts and 80 to 90 per cent. reductions in the body temperature counts were produced in twenty-four hours. Complete sterilization, or even a reduction of bacterial contents to within the drinking water, or 100–10–5 standard, was effected only when the sodium benzoate was present as a 10 per cent. solution.

EXAMINATION OF SEWER OUTLETS AND THE EFFECT OF SEWAGE DISPOSAL,

1911.

EXAMINATION OF SEWER OUTLETS AND THE EFFECT OF SEWAGE DISPOSAL, 1911.

A general statement of the results of the annual examination of sewer outlets, especially the outlets of main sewers discharging into the sea, has been given in an earlier part of this report, pages 21–23, and a list of the cities and towns having sewerage systems, together with the population and valuation of these towns, will be found in subsequent pages. Of the cities and towns in the State having systems of sewerage, 24 are connected with the main sewers of the Boston and Metropolitan systems discharging into Boston Harbor at the three main outlets, — Moon Island, Deer Island and Peddock's Island, — and 15 dispose of their sewage into the sea by independent outlets. The remaining cities and towns having sewerage systems — 64 in number — discharge their sewage into inland streams, and of these, 32 have provided themselves with works for purifying the sewage or subjecting it to some form of treatment for the removal of organic matters before its final disposal.

The results of the examination of the various rivers into which the sewage of certain inland cities and towns is discharged are summarized on pages 27–33 of this report. The cities and towns having works for the purification or treatment of part or all of the sewage are the following: —

Amherst.[1]
Andover.
Attleborough.[1]
Billerica.
Brockton.
Clinton.
Concord.
Easthampton.
Framingham.
Franklin.
Gardner.
Hopedale.
Hudson.
Leicester.
Lenox.
Longmeadow.
Marion.
Marlborough.
Maynard.
Medfield.
Milford.
Natick.
North Attleborough.[1]
Northbridge.
North Brookfield.
Norwood.
Pittsfield.
Southbridge.
Spencer.
Stockbridge.
Westborough.
Worcester.

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[1] Constructed in 1911.

All of the disposal works have been examined frequently during 1911, and numerous samples of the sewage and effluent, collected from the various sewer outlets and disposal works, have been examined during the year, the results of which are summarized in the tables which follow.

The sewage purification works at Billerica, Easthampton, Franklin, Lenox, Longmeadow, Medfield and North Brookfield, at which only a part of the sewage from the various towns is treated, and the works maintained by public and private institutions of various kinds are frequently examined, but the methods of purification followed and the results obtained present little of additional interest. New works for the purification of the sewage of the town of Attleborough will probably be operated in 1912.

A brief description of the more important works as they existed in 1911 and the results of their operation during that year follow: —

AMHERST.

New works for the purification of the sewage of somewhat more than one-half of the main village of Amherst were completed and first operated in the early summer of 1911. The works comprise 2 small settling tanks, 2 sludge beds and 2 acres of filter beds. The filters are composed of a rather fine sand, and are underdrained at a depth of 4 to 4.5 feet by drains 25 feet apart.

The results of the analyses of a few samples of sewage and effluent collected during the latter part of 1911 will be found in the appended tables.

ANDOVER.

Works for the purification of the sewage of Andover, which were constructed in 1898, comprise coarse screens, a settling tank, 2 sludge beds and 20 filter beds with a net filtration area of 3.65 acres. The beds are underdrained with lines of pipe 4 feet in depth and 20 feet apart.

The efficiency of these filters, as indicated by analyses presented in the tables which follow, is poor.

BROCKTON.

The works at Brockton, which were constructed in 1893, with extensive additions in 1905 and 1908, consist of 37 filter beds with a net filtration area of approximately 37 acres. Many of the filter beds are underdrained with lines of pipe about 5.5 feet in depth and about 30 feet apart. A storage reservoir is provided at the pumping station for the storage of the sewage flowing at night.

The sewage is passed through a fine mesh rotary screen, first operated during the past year, and the removal of organic matter by the screen has permitted the operation of the filters at a higher rate than formerly. The sewage is particularly strong, containing a considerable quantity of factory wastes, and, while the effluent from the filters contains larger quantities of organic matter than many other effluents, the amount of organic matter removed, as indicated by albuminoid ammonia, is comparatively high, although the removal of free ammonia and oxygen consumed is not as high. The amount of organic matter converted into nitrates is comparatively low. The plant is badly crowded at times, but the sewage is fairly evenly distributed and the surfaces of the beds are well taken care of. Additions to the purification works are contemplated in the year 1912.

CLINTON.

The works at Clinton, which were constructed in 1898–99, comprise a coarse screen, a storage reservoir at the pumping station, a system of settling basins so used that the period of sedimentation is between three and five hours, and a filtration area of 26.23 acres. The filter beds, which are composed of sand and gravel of excellent quality for the purpose, are underdrained by lines of pipe 8 feet in depth and between 60 and 70 feet apart.

The sewage contains a considerable quantity of waste from the scouring of wool. Since the reconstruction of the underdrainage system and the more thorough distribution of the sewage the efficiency of the works has been comparatively high.

CONCORD.

The works at Concord, which were constructed in 1899, comprise a coarse screen, a storage reservoir at the pumping station and 4 filter beds with a net filtration area of 3.3 acres. Artificial underdrainage was found unnecessary when the filters were constructed, a stratum of very coarse material at suitable depth providing adequate underdrainage for present needs. The results of the operation of these filters have been very satisfactory.

FRAMINGHAM.

The sewage purification works at Framingham, constructed in 1890, consist of a coarse screen, a storage reservoir at the pumping station and 20 filter beds with a net filtration area of 20.75 acres. The beds were prepared by the removal of trees and stumps and by levelling where necessary. Only a portion of the works is artificially underdrained.

The sewage contains a considerable quantity of trades waste, mainly spent dyes from a large factory in which paper is handled. Considerable attention is given to the raising of corn, and at times in the past year the sewage has not been distributed evenly over the area, but has been discharged in part to low areas surrounding the works.

GARDNER.

Gardner Area.

The original works at Gardner, constructed in 1891, comprise 2 small settling tanks, 2 sludge beds and 21 filter beds, with a net filtration area of 2.5 acres. The sand of which the beds are composed was largely handled during construction and is of excellent quality. The beds are underdrained with lines of pipe 20 feet apart and 5 feet in depth.

During a large portion of the time since these works were constructed the filters have been badly overdosed, having been used probably for the treatment of more sewage per acre than any other works in the State, but the efficiency is now remarkably high owing to the fact that they are operated at a low rate which is made possible by the discharge of a large part of the sewage through a bypass to the Templeton works. When not overdosed the efficiency of these filters is high. The sewage discharged upon these filter beds is probably a shorter time in transit than that discharged at any other disposal works in the State.

Templeton Area.

These works, constructed in 1901, with extensive additions in 1909, comprise 4 settling tanks, 4 coke strainers with an area of ½ an acre, 6 sludge beds, with an aggregate area of 1 acre, and 26 filter beds with an aggregate area of 10 acres. The sand of which the filter beds are composed, all of which was handled during construction, is of excellent quality for the purpose. The beds are underdrained with lines of pipe 20 to 30 feet apart and between 3 and 4 feet in depth. The coke strainers, which are composed of coke breeze 8 inches deep supported by crushed stone and thoroughly underdrained, become clogged rapidly and are not in continuous operation as strainers.

The sewage, which passes through a siphon and is afterward given a comparatively long period of sedimentation in large tanks, is probably at times in a septic condition when discharged upon the filter beds. Owing to the lack of coarse material around the underdrains, and to the excessive rate of operation, the beds at Templeton were completely and continuously saturated with sewage during the first few months of the year 1911. During the summer, however, the drains were taken up, cleaned and relaid with a quantity of coarse material surrounding them sufficient to provide for their efficient operation. The low efficiency, as shown in the subsequent tables, is due in part to the poor underdrainage in the early part of the year. The results since the reconstruction of the underdrainage system show great improvement. Recommendations of the Board regarding this works may be found on page 165 of this report.

HOPEDALE.

The works at Hopedale, constructed in 1900, consist of a large tank designed as a septic tank and 7 sand filter beds with a net area of 3.25 acres. Much of the sand of which the filters are composed is of excellent quality for the purpose, but some of it is rather fine and the filters are in places underlaid by ledge. The beds are underdrained with lines of pipe 4 feet in depth and 60 feet apart. The filters are located at no great distance from a thickly settled community, but are surrounded by trees and appear to be unobjectionable.

HUDSON.

The works at Hudson, which were constructed in 1904 with additions in 1910, consist of a large settling tank divided into four compartments, only three of which are ordinarily used, an automatic dosing apparatus and 24 filter beds with a net filtration area of 9 acres. The beds are composed of sand of excellent quality for the purpose, and are underdrained with lines of pipe between 60 and 100 feet apart and between 5 and 6 feet in depth. The sewage is pumped to the filtration area by pumps which are automatically started and stopped by the rise and fall of sewage in the pump-well, and it is also automatically distributed onto the various beds in rotation by an apparatus which is operated by the rise and fall of sewage in the dosing tank.

The sewage of Hudson contains a considerable quantity of trades waste, mainly from a tannery, and is high in organic matter, but a considerable portion of the organic matter is removed from the sewage in its passage through the settling tanks. At times the sewage applied to the filters is septic, but the efficiency of the works is comparatively high.

LEICESTER.

The works at Leicester, which were constructed in 1894, comprise a small settling tank, a small sludge bed, 8 filter beds, with a net filtration area of 0.36 of an acre, and a ditch 800 feet in length, 1 foot deep and 3 feet in width. The sand of which the filter beds is composed is very hard and compact. Much of it was loosened in construction, but apparently has again become compact and does not permit of the passage of large quantities of sewage. The beds are underdrained with lines of pipe 8 feet apart and 4 feet in depth.

MARION.

The works at Marion, which were constructed in 1906, consist of 8 filters with a net filtration area of 0.66 of an acre. The beds are composed of sand much of which is of good quality for the purpose, but there are pockets of fine sand and the filters are in places underlaid by ledge. Two main lines of underdrains 5 feet in depth extend through the beds and, in addition, there are short lines of lateral underdrains in the middle of each bed.

The leakage into the Marion sewers is very large, and on this account great quantities of dilute sewage are discharged upon the filter beds. The beds are not capable of maintaining the necessary rate of operation, and they have not received proper attention owing to inexperience in the operation of disposal works. The Board during the past year made certain recommendations relative to this plant, which may be found on page 175.

MARLBOROUGH.

The purification works at Marlborough, which were constructed in 1891, with additions in 1908, 1909, 1910 and 1911, comprise a coarse screen, a large settling tank, a dosing tank, 6 beds for the disposal of sludge, with an aggregate area of 0.73 of an acre, and 30 beds for the purification of sewage with a total net area of 20.9 acres. The filter beds are underdrained with lines of pipe 4.5 to 6.0 feet in depth and between 30 and 35 feet apart. Since the construction of additional filter beds, and the reconstruction of the older portion of the works, the efficiency of the works has been very high and has been well maintained throughout all seasons of the year. The sewage is well distributed over the entire area, and the surfaces of the beds are well cared for.

MILFORD.

The works at Milford, first used in 1907, consist of settling tanks so operated as to allow a period of sedimentation averaging between four and six hours, and 16 filter beds with a net filtration area of 9.3 acres. The sand of which the filter beds are composed is rather fine for the purpose, but is apparently capable of purifying the sewage efficiently at the present rate. The beds are thoroughly underdrained with lines of pipe 5 feet in depth and 40 feet apart. Portions of the beds are at times overdosed owing to the fact that the discharge from the dosing tank does not always cover an entire bed.

NATICK.

The works at Natick, which were constructed in 1896, comprise a coarse screen, a storage reservoir at the pumping station and 14 filter beds with a net filtration area of 12.6 acres. Much of the sand of which the beds are composed is of fairly good quality for the purpose, but some of the beds contain strata of very fine material. The beds are underdrained with lines of pipe 6 feet in depth and about 36 feet apart.

At times of the year the works are badly crowded, owing to excessive leakage into the sewers in wet periods. A few years ago the filters became badly clogged, and the main lines of underdrains were uncovered and found to be nearly watertight and surrounded with but a very small quantity of coarse material. The main lines of underdrains have since been removed, cleaned and replaced and surrounded with a considerable quantity of crushed stone, and since this reconstruction the works have been in satisfactory operation. The surfaces of the beds are well cared for. Advice of the Board relative to this plant will be found on page 178 of this report.

NORTHBRIDGE.

The works at Northbridge, constructed in 1906, comprise 4 settling tanks so operated as to allow a period of sedimentation of between two and four hours, 6 sludge beds and 24 filter beds with a total net filtration area of 6.75 acres. The filters which are composed of coarse sand and gravel are underdrained with lines of open-jointed tile pipe 4 feet in depth and between 50 and 75 feet apart. The plant is well cared for, although the even distribution of the sewage is made difficult in the summer by a vigorous growth of weeds. Owing to the porosity of the material the beds are quickly drained.

NORWOOD.

The works at Norwood, first used in 1909, consist of a large settling tank, an automatic dosing tank of over 100,000 gallons' capacity, a sludge bed, with an area of 0.13 of an acre, and 6 filter beds with a net filtration area of 6.64 acres. The beds are underdrained with lines of tile pipe from 4 to 6 feet in depth and about 40 feet apart.

The sewage is very strong and contains a great quantity of factory wastes. In the operation of the works two filters are ordinarily used for a week at a time, and the efficiency of the works would probably be improved if the sewage were more thoroughly and evenly distributed over the entire area.

PITTSFIELD.

The works at Pittsfield, which were constructed in 1901, consist of a coarse screen and storage reservoir at the pumping station and a sand filtration area of 25.9 acres, a small portion of which is used for the disposal of sludge. The beds are underdrained with lines of pipe 4 feet in depth and 35 feet apart.

The sewage contains a considerable quantity of trades waste, but as yet this factor has not interfered with the operation of the filters. The works are ordinarily well maintained and the sewage distributed fairly evenly over the entire area. In the winter the temperature of the sewage is very low for considerable periods, and ice to a thickness of 18 inches forms on the surfaces of the filters. The area of the filters is then slightly reduced, but the beds are deeply furrowed, and, as the sewage is discharged under the ice, no serious difficulty arises.

SOUTHBRIDGE.

The new works at Southbridge, which were constructed in 1908, comprise 3 settling tanks, 4 sludge beds, with an area of 0.7 of an acre, and 11 filter beds with a net filtration area of 8.5 acres. The sand of which the beds are composed has an effective size, according to the results of the examination of six samples, of about 0.2 of a millimeter and a uniformity coefficient between 4.5 and 15. The beds are underdrained with lines of tile pipe 4 feet in depth and about 40 feet apart.

The quantity of sewage discharged upon the filters is at times greater than they are capable of purifying efficiently, and the sewage is not distributed evenly over the area. The filters are at times covered by an excessive growth of weeds in the summer time. The efficiency of these filters is poor. Advice of the Board relative to this plant will be found on page 183 of this report.

SPENCER.

The works at Spencer, constructed in 1897, consist of 11 filter beds with a total net filtration area of 9.3 acres, only a small portion of which is underdrained. The sand of which the beds are composed is of excellent quality for the purpose.

The works are ordinarily operated with care, but during portions of the year the sewage is not evenly distributed over the entire area. When the water in the ground is high the entire quantity of sewage is not conveyed to the filter beds.

STOCKBRIDGE.

The works at Stockbridge, which were first operated in 1899, consist of 4 sand filter beds, with an area of 1 acre, and an irrigation field with an area of 2.6 acres. The filter beds are composed of sand of good quality, but the soil of the irrigation field contains much fine material. The filter beds and the irrigation field are underdrained with lines of pipe from 3 to 4.5 feet deep and 23 feet apart in the filter beds and 30 feet apart in the irrigation field. The filter beds are not used in the cold weather, all of the sewage being discharged onto the irrigation field.

WESTBOROUGH.

The works at Westborough, which were first operated in 1892, but which have since been reconstructed and added to, consisted during the year 1911 of 12 filter beds with a net filtration area of 5.0 acres. Practically all of the sand of which the beds are composed was handled during construction, and it is all of excellent quality for the purpose. The beds are underdrained with lines of tile pipe between 30 and 40 feet apart and 5 feet in depth.

The sewage discharged at these works varies considerably in strength from season to season, owing to leakage and to the discharge of factory wastes into the sewers. For a few years previous to 1911 the sewage contained a great quantity of waste from the manufacture of yeast, which greatly impaired the efficiency of the plant, but since the elimination of this waste from the sewage, the construction of additional beds and the removal of a considerable quantity of surface sand, which was clogged by the sewage containing the yeast wastes, the efficiency has been increased and during the past year has been well maintained. The sewage is well distributed over the entire area, and the surfaces of the beds receive careful attention.

WORCESTER.

The works at Worcester comprise a grit chamber, a chemical precipitation plant in which the light sewage is treated with lime and given a sedimentation period averaging seven hours, and a sand filtration area consisting of 75 beds with a total net area of 74.3 acres, which is used for the treatment of the heavy day sewage. These beds are constructed of sand of excellent quality for the purpose and are underdrained with lines of pipe 4 to 6 feet in depth and from 35 to 50 feet apart. The precipitation plant was constructed in 1891 and the first of the filter beds in 1898.

The entire plant is operated with great care, but the efficiency of the sand filtration area is probably somewhat impaired by chemicals contained in the sewage which are introduced into the sewers from various manufacturing establishments. Experiments are being carried on at this works relative to the disposal of sewage in tanks with separate compartments for the digestion of sludge and by filtration through sprinkling filters.

The results of analyses of sewage from many of the sewage-disposal works in the State are presented in the following tables. At some of the works composite samples of the sewage are collected throughout the day and doubtless give a fair average of the character of the sewage and effluent from settling tanks. In some cases it has been difficult to obtain representative samples of the sewage, but in nearly all cases it is probable that the effluent is quite representative, though a number of the effluents contain a considerable quantity of ground and rain water.

TABLE No. 1. — *Average Results of the Analyses of Monthly Samples of Sewage, arranged according to the Amount of Total Albuminoid Ammonia.*

[Parts in 100,000.]

	RESIDUE ON EVAPORATION.						AMMONIA.					OXYGEN CONSUMED.		IRON.		
	TOTAL RESIDUE.			LOSS ON IGNITION.				ALBUMINOID.								
	Total.	Dissolved.	Suspended.	Total.	Dissolved.	Suspended.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Unfiltered.	Filtered.	Unfiltered.	Filtered.	Kjeldahl Nitrogen.
Hudson,	256.60	206.90	49.70	68.55	41.43	27.12	5.37	2.28	1.53	.75	87.34	16.45	8.45	.22	.05	4.82
Gardner (old area),	82.95	42.57	40.38	52.35	20.01	32.34	7.63	1.73	.81	.92	6.48	12.15	5.74	.28	.08	3.31
Framingham,	122.87	60.30	62.57	78.90	26.82	52.08	6.22	1.71	.94	.77	11.05	13.99	6.97	.29	.07	3.34
Gardner (Templeton area),	91.33	51.80	39.53	52.40	19.42	32.98	7.31	1.53	.85	.68	13.17	10.33	6.01	.30	.05	3.08
Marlborough,	128.73	55.35	73.38	88.52	21.40	67.12	6.49	1.45	.67	.78	13.19	11.31	5.60	.29	.08	2.71
Brockton,	93.48	57.15	36.33	52.77	22.28	30.49	7.26	1.42	.64	.78	13.47	17.60	10.40	.28	.13	2.57
Andover,	95.60	55.22	40.38	53.67	22.73	30.94	5.37	1.42	.73	.69	7.90	11.21	6.07	.34	.09	2.91
Hopedale,	69.45	38.38	31.07	41.57	19.68	21.89	7.43	1.39	.79	.60	8.27	9.91	5.93	.53	.07	3.00
Norwood,	170.89	120.84	50.05	66.98	29.56	37.42	3.72	1.23	.44	.79	48.15	21.40	8.96	–	–	2.48
Worcester (day),	112.22	73.75	38.47	46.66	19.57	27.09	3.66	1.16	.44	.72	14.98	16.07	7.77	4.31	1.51	2.58
Clinton,	89.93	63.47	26.46	48.27	28.40	19.87	5.78	1.03	.65	.38	8.08	11.25	7.85	.24	.10	2.02
Spencer,	58.65	38.23	20.42	34.15	18.87	15.28	4.75	1.01	.57	.44	6.82	8.36	4.05	.24	.07	1.99
Northbridge,	57.73	35.88	21.85	30.22	14.30	15.92	4.48	1.00	.50	.50	8.43	7.46	4.54	–	–	1.91
Milford,	74.44	54.89	19.55	35.22	17.60	17.62	4.47	.87	.46	.41	16.25	7.06	4.59	.16	.05	1.62
Southbridge,	53.47	32.43	21.04	32.90	15.25	17.65	3.69	.80	.42	.38	5.33	7.11	4.36	–	–	1.53
Westborough,	47.18	33.32	13.86	26.65	16.09	10.56	3.72	.80	.49	.31	5.23	6.43	4.24	.19	.10	1.49
Leicester,[1]	46.90	29.90	17.00	27.00	13.37	13.63	4.07	.74	.44	.30	4.99	5.73	3.47	.20	.08	1.47
Concord,[1]	52.17	26.23	25.94	36.13	13.88	22.25	1.88	.62	.29	.33	3.73	6.17	2.91	.26	.11	1.20
Natick,	53.62	43.92	9.70	24.35	16.92	7.43	3.91	.56	.30	.26	8.65	4.61	3.11	.16	.05	1.16
Stockbridge,	34.28	22.25	12.03	19.10	9.57	9.53	1.76	.49	.27	.22	1.96	3.51	1.97	–	–	.90
Pittsfield,	45.31	34.73	10.58	21.57	13.68	7.89	2.23	.48	.28	.20	4.83	3.92	2.65	.15	.05	.99
Amherst,[2]	23.30	18.70	4.60	12.10	10.00	2.10	1.09	.34	.15	.19	2.95	2.45	1.76	–	–	.72
Marion,	18.48	15.27	3.21	8.77	6.70	2.07	.82	.17	.11	.06	3.27	1.79	1.23	–	–	.40

[1] Every other month.

[2] Every three months.

TABLE NO. 2. — *Average Results of Analyses of Monthly Samples of Settled Sewage, arranged according to Amount of Total Albuminoid Ammonia.*

[Parts in 100,000.]

	RESIDUE ON EVAPORATION.						AMMONIA.				Chlorine.	OXYGEN CONSUMED.		IRON.		Kjeldahl Nitrogen.
	TOTAL RESIDUE.			LOSS ON IGNITION.				ALBUMINOID.								
	Total.	Dissolved.	Suspended.	Total.	Dissolved.	Suspended.	Free.	Total.	Dissolved.	Suspended.		Unfiltered.	Filtered.	Unfiltered.	Filtered.	
Gardner (old area), ...	82.95	42.57	40.38	52.35	20.01	32.34	7.63	1.73	.81	.92	6.48	12.15	5.74	.2792	.0812	3.31
Framingham, ...	122.87	60.30	62.57	78.90	26.82	52.08	6.22	1.71	.94	.77	11.05	13.99	6.97	.2917	.0650	3.34
Marlborough, ...	128.73	55.35	73.38	88.52	21.40	67.12	6.49	1.45	.67	.78	13.19	11.31	5.60	.2900	.0800	2.71
Brockton, ...	93.48	57.15	36.33	52.77	22.28	30.49	7.26	1.42	.64	.78	13.47	17.60	10.40	.2800	.1300	2.57
Worcester (day), . . .	112.22	73.75	38.47	46.66	19.57	27.09	3.66	1.16	.44	.72	14.98	16.07	7.77	4.3100	1.5100	2.58
Spencer, ...	58.65	38.23	20.42	34.15	18.87	15.28	4.75	1.01	.57	.44	6.82	8.36	4.05	.2420	.0665	1.99
Norwood (settled), . . .	147.58	123.16	24.42	43.44	28.54	14.90	3.92	.86	.37	.49	48.46	14.59	9.23	–	–	1.82
Andover (settled), . . .	54.56	41.76	12.80	26.07	17.64	8.43	5.31	.84	.48	.36	8.46	6.38	4.29	.1398	.0689	1.60
Westborough, ...	47.18	33.32	13.86	26.65	16.09	10.56	3.72	.80	.49	.31	5.23	6.43	4.24	.1905	.0960	1.49
Clinton (settled), . . .	68.27	55.75	12.52	35.27	25.45	9.82	4.37	.80	.53	.27	7.13	8.44	6.57	.1900	.1000	1.52
Gardner (Templeton) (settled),	45.77	33.10	12.67	21.43	11.55	9.88	5.00	.75	.47	.28	7.67	4.93	3.21	.1858	.0710	1.48
Hudson (settled), . . .	112.68	99.83	12.85	27.75	18.65	9.10	4.81	.73	.46	.27	40.15	6.93	4.12	.2435	.0492	1.36
Hopedale (settled), . . .	43.85	34.67	9.18	22.80	15.32	7.48	6.26	.68	.45	.23	6.52	5.95	3.85	.2600	.1300	1.28
Concord, ...	52.17	26.23	25.94	36.13	13.88	22.25	1.88	.62	.29	.33	3.73	6.17	2.91	.2550	.1125	1.20
Natick, ...	53.62	43.92	9.70	24.35	16.92	7.43	3.91	.56	.30	.26	8.65	4.61	3.11	.1628	.0492	1.16
Milford (settled), . . .	48.58	41.43	7.15	19.38	14.37	5.01	3.38	.56	.36	.20	11.22	4.68	3.48	.1177	.0569	1.11
Leicester, (settled), . . .	41.33	30.23	11.10	21.73	13.47	8.26	3.88	.52	.33	.19	5.39	4.80	3.10	.1700	.0600	.99
Stockbridge, ...	34.28	22.25	12.03	19.10	9.57	9.53	1.76	.49	.27	.22	1.96	3.51	1.97	–	–	.90
Southbridge (settled), . .	31.17	25.53	5.64	14.93	10.68	4 25	3.32	.49	.32	.17	4.83	4.04	3.03	–	–	.92
Pittsfield, ...	45.31	34.73	10.58	21.57	13.68	7.89	2.23	.48	.28	.20	4.83	3.92	2.65	.1450	.0520	.99
Northbridge (settled), . .	31.56	25.48	6.08	15.31	11.62	3.69	3.56	.46	.29	.17	4.59	3.89	2.71	–	–	.93
Amherst, ...	23.30	18.70	4.60	12.10	10.00	2.10	1.09	.34	.15	.19	2.95	2.45	1.76	–	–	.72
Marion, ...	18.48	15.27	3.21	8.77	6.70	2.07	0.82	.17	.11	.06	3.27	1.79	1.23	–	–	.40

In the following tables are given the results of the operation of settling tanks at the various filtration areas during the year 1911. These results have been obtained from analyses of the sewage as it enters the settling tanks at the various filtration areas and from analyses of the effluent as it flows from the tanks to the filters. There is of course in the sewage of most towns a considerable variation in different parts of the day, and where there is a large leakage of ground water the night sewage often varies greatly from the average during the day. In a large proportion of the works it has been practicable to obtain samples of effluent from settling tanks which, judging from the chlorine, represent fairly closely the average strength of the sewage entering the tanks, but in a number of cases the effluents from settling tanks apparently represent much weaker sewage than that entering the tanks at the time the samples were collected. This is especially the case at Hudson, Marlborough, Northbridge and Gardner and, to some extent, at Hopedale and Milford.

TABLE NO. 3. — *Efficiency of Settling Tanks, arranged in Order of Per Cent. Removal of Albuminoid Ammonia.*

[Parts in 100,000.]

CITY OR TOWN.	SUSPENDED SOLIDS.			TOTAL ALBUMINOID AMMONIA.			OXYGEN CONSUMED.			CHLORINE.		Approximate Period of Sedimentation (Hours).	Area of Sludge Beds (Acres).
	Raw Sewage.	Settled Sewage.	Per Cent. removed.	Raw Sewage.	Settled Sewage.	Per Cent. removed.	Raw Sewage.	Settled Sewage.	Per Cent. removed.	Raw Sewage.	Settled Sewage.		
Hudson,	49.70	12.85	74	2.28	.73	68	16.45	6.93	58	87.34	40.15	25–40	.35
Marlborough,[1]	33.95	7.15	79	1.63	.56	66	12.00	4.54	62	20.78	9.42	–	.73
Northbridge,	21.85	6.08	72	1.00	.46	54	7.46	3.89	48	8.43	4.59	2–4	–
Gardner (Templeton area),	39.53	12.67	68	1.53	.75	51	10.33	4.93	52	13.17	7.67	7–9	1.00
Hopedale,	31.07	9.18	70	1.39	.68	51	9.91	5.95	40	8.27	6.52	14–20	–
Andover,	40.38	12.80	68	1.42	.84	41	11.21	6.38	43	7.90	8.46	1–2	.15
Southbridge,	21.04	5.64	73	.80	.49	39	–	–	–	4.61	5.33	3–6	.70
Milford,	19.55	7.15	63	.87	.56	36	7.06	4.68	34	16.25	11.22	4–6	.36
Worcester,	29.57	9.18	69	.66	.46	30[2]	9.63	4.67	52	7.73	9.05	7	–
Norwood,	50.05	24.42	51	1.23	.86	30	21.40	14.59	32	48.15	48.46	–	.13
Leicester,	17.00	11.10	35	.74	.52	30	5.73	4.80	16	4.99	5.39	7–10	.005
Clinton,	26.46	12.52	53	1.03	.80	22	11.25	8.44	25	8.08	7.13	3–5	–

[1] Last four months only.

[2] Removal of suspended albuminoid ammonia 68 per cent.

TABLE No. 4. — *Average Results of the Analyses of Monthly Samples of Effluent, arranged according to the Amount of Total Albuminoid Ammonia.*

[Parts in 100,000.]

	Color.	Total Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen consumed.	Iron.
			Free.	Total Albuminoid.		Nitrates.	Nitrites.		
Concord,	.03	23.43	.05	.0121	3.57	1.0000	.0069	.18	.0060
Milford,	.12	40.12	.72	.0357	10.13	1.1683	.0056	.49	.0236
Marion,	.26	15.35	.42	.0461	3.49	.1300	.0036	.62	.3807
Stockbridge,[1]	.22	24.87	.20	.0473	3.28	.3260	.0040	.50	.1290
Framingham,[2]	.43	37.65	.90	.0512	8.58	.5883	.0275	.63	.4721
Northbridge,[3]	.13	22.81	.49	.0537	5.10	.7075	.0086	.53	.0217
Natick,	.26	32.31	.93	.0576	6.57	.7296	.0485	.56	.2397
Pittsfield,[3]	.25	35.06	.37	.0621	4.83	.9309	.0196	.64	.0169
Norwood,	–	79.95	1.25	.0635	33.22	.2182	.0214	1.24	.8682
Clinton,[3]	.48	38.39	.75	.0653	5.98	.9394	.0128	.89	.5300
Spencer,[3]	–	26.45	1.04	.0682	5.45	.6088	.0043	.74	.4042
Marlborough,[3]	.19	38.64	1.42	.0714	7.95	1.3924	.0147	.74	.0894
Hudson,	.34	92.35	1.48	.0867	34.64	.7850	.0243	.87	.3023
Gardner (old area),	.17	37.39	1.43	.0888	5.46	1.5358	.0325	.88	.3687
Westborough,[3]	–	29.40	.82	.0900	5.02	.7400	.0206	1.04	.6100
Southbridge,[3]	–	21.71	1.62	.0900	4.40	.0527	.0149	1.12	1.7973
Leicester,	–	21.40	1.22	.0950	3.57	.1930	.0091	1.35	.4906
Amherst,	.42	16.53	.70	.0987	2.57	.1117	.0232	.79	.4900
Brockton,[3]	–	47 66	3.17	.1092	12.91	.4011	.0107	1.74	2.2700
Andover,[3]	–	29.08	2.24	.1301	6.92	.1802	.0102	1.27	.9563
Worcester,[2]	–	67.30	2.37	.1362	15.23	.1187	.0195	2.20	2.5900
Hopedale,[3]	.41	29.66	2.74	.1740	5.61	.8746	.0263	1.44	.0789
Gardner (Templeton area),[3]	–	39.88	3.57	.1867	7.64	.2505	.0175	1.83	2.5233

[1] Combined filter and irrigation field.

[2] Combined east and west underdrains.

[3] Combined.

TABLE NO. 5. — *Filter Effluents arranged according to the Amount of Total Albuminoid Ammonia in the Applied Sewage.*

[Parts in 100,000.]

CITY OR TOWN.	Nitrates in Effluent.	Nitrites in Effluent.	Iron in Effluent.	Albuminoid Ammonia in Applied Sewage.
Gardner (old area),	1.5358	.0325	.3687	1.73
Framingham,	.5883	.0275	.4721	1.71
Marlborough,	1.3924	.0147	.0894	1.45
Brockton,	.4011	.0107	2.2700	1.42
Worcester,	.1187	.0195	2.5900	1.16
Spencer,	.6088	.0043	.4042	1.01
Norwood,	.2182	.0214	.8682	.86
Andover,	.1802	.0102	.9563	.84
Clinton,	.9894	.0128	.5300	.80
Westborough,	.7400	.0206	.6100	.80
Gardner (Templeton area),	.2505	.0175	2.5233	.75
Hudson,	.7850	.0243	.3023	.73
Hopedale,	.8746	.0263	.0789	.68
Concord,	1.0000	.0069	.0060	.62
Milford,	1.1683	.0056	.0236	.56
Natick,	.7296	.0485	.2397	.56
Leicester,	.1930	.0091	.4906	.52
Southbridge,	.0527	.0149	1.7973	.49
Stockbridge,	.3260	.0040	.1290	.49
Pittsfield,	.9309	.0196	.0169	.48
Northbridge,	.7075	.0086	.0217	.46
Medfield,	.0362	.0020	.0697	.44
Amherst,	.1117	.0232	.4900	.34
Marion,	.1300	.0036	.3807	.17

TABLE No. 6. — *Showing Extent of Sewerage System,*[1] *the Approximate Average Amount of Sewage discharged at most of the Works, the Net Area of the Filters and the Average Rate of Operation.*

CITY OR TOWN.	Population 1910.	Length of Sewers (Miles).	Average Flow (Gallons per Day).	Area (Acres).	Rate of Operation with Even Distribution of Sewage (Gallons per Acre per Day).
Amherst,	5,112	6.5	325,000[2]	2.00	163,000
Andover,	7,301	10.7	200,000	3.65	55,000
Brockton,	56,878	65.0	1,547,000[2]	37.00	42,000
Clinton,	13,075	21.6	826,000[3]	26.23	31,500
Concord,	6,421	7.9	274,000[3]	3.30	83,000
Framingham,	12,984	18.2	532,000[3]	20.75	25,600
Gardner (old area),	14,699	25.8	130,000	2.50	52,000
Gardner (Templeton area),	-	-	520,000	10.00	52,000
Hopedale,	2,188	-	103,000[3]	3.25	31,700
Hudson,	6,743	8.0	213,000	9.00	23,700
Marion,	1,460	3.1	80,000[2]	.66	121,000
Marlborough,	14,579	25.3	600,000	20.90	29,000
Milford,	13,055	-	374,000	9.30	40,200
Natick,	9,866	13.8	509,000[3]	12.60	40,400
Northbridge,	8,807	12.8	197,000	6.75	29,200
Norwood,	8,014	12.5	400,000	6.64	60,000
Pittsfield,	32,121	48.1	1,819,000[3]	25.90	70,300
Southbridge,	12,592	12.6	800,000[2]	8.50	94,000
Spencer,	6,740	-	407,000	9.30	43,800
Westborough,	5,446	-	260,000	5.00	52,000
Worcester,	145,986	83.4[4]	4,910,000	74.30	66,100

[1] All separate systems.

[2] Estimated.

[3] Quantity pumped.

[4] Sewage only, 65.8 miles for sewage and surface water.

The population and valuation of all of the cities and towns in Massachusetts in 1910 are given in the following table, in which those cities and towns having sewerage systems are separated from those not having sewerage systems. The cities and towns are arranged according to their population in 1910, and the rank of each according to the last three decennial censuses is also given.

Table No. 7.

CITY OR TOWN.	POPULATION IN 1910.		Valuation, 1910.	RANK ACCORDING TO POPULATION.		
	Places with Sewerage Systems.	Places without Sewerage Systems.		1890.	1900.	1910.
BOSTON,	670,585	-	$1,420,981,033	1	1	1
WORCESTER,	145,986	-	146,201,068	2	2	2
FALL RIVER,	119,295	-	95,129,690	4	3	3
LOWELL,	106,294	-	85,175,700	3	4	4
CAMBRIDGE,	104,839	-	114,094,902	5	5	5
NEW BEDFORD,	96,652	-	87,503,240	9	8	6
LYNN,	89,336	-	74,081,912	6	6	7
SPRINGFIELD,	88,926	-	116,218,874	8	9	8
LAWRENCE,	85,892	-	64,241,036	7	7	9
SOMERVILLE,	77,236	-	65,411,419	10	10	10
HOLYOKE,	57,730	-	50,506,650	11	11	11
BROCKTON,	56,878	-	43,911,145	15	12	12
MALDEN,	44,404	-	45,004,522	19	16	13
HAVERHILL,	44,115	-	32,577,268	14	13	14
SALEM,	43,697	-	36,023,941	12	14	15
NEWTON,	39,806	-	80,837,081	18	17	16
FITCHBURG,	37,826	-	30,815,118	20	18	17
TAUNTON,	34,259	-	25,326,745	16	19	18
EVERETT,	33,484	-	27,342,393	32	21	19
QUINCY,	32,642	-	30,606,390	23	23	20
CHELSEA,	32,452	-	25,493,242	13	15	21
PITTSFIELD,	32,121	-	24,474,469	22	25	22
WALTHAM,	27,834	-	28,563,213	21	24	23
Brookline,	27,792	-	118,513,924	30	26	24
CHICOPEE,	25,401	-	13,925,483	26	27	25
GLOUCESTER,	24,398	-	23,264,233	17	20	26
MEDFORD,	23,150	-	24,264,078	31	29	27
NORTH ADAMS,	22,019	-	16,546,648	24	22	28
NORTHAMPTON,	19,431	-	15,006,637	25	28	29
BEVERLY,	18,650	-	36,806,035	34	32	30
Revere,	18,219	-	15,660,186	66	46	31
Leominster,	17,580	-	12,836,174	53	37	32
Attleborough,	16,215	-	15,186,731	49	41	33
Westfield,	16,044	-	9,849,516	38	38	34
Peabody,	15,721	-	11,110,151	37	39	35

Table No. 7 — Continued.

CITY OR TOWN.	POPULATION IN 1910.		Valuation, 1910.	RANK ACCORDING TO POPULATION.		
	Places with Sewerage Systems.	Places without Sewerage Systems.		1890.	1900.	1910.
MELROSE,	15,715	-	$17,063,560	45	36	36
Hyde Park,	15,507	-	15,041,961	36	35	37
WOBURN,	15,308	-	11,638,886	29	31	38
NEWBURYPORT,	14,949	-	13,228,615	27	30	39
Gardner,	14,699	-	7,999,254	46	45	40
MARLBOROUGH,	14,579	-	10,898,089	28	34	41
Clinton,	13,075	-	8,841,229	35	33	42
Milford,	13,055	-	8,830,094	43	40	43
Adams,	13,026	-	7,165,492	41	44	44
Framingham,	12,948	-	12,041,289	40	43	45
Weymouth,	-	12,895	8,323,916	33	42	46
Watertown,	12,875	-	15,479,139	55	48	47
Southbridge,	12,592	-	6,392,075	48	47	48
Plymouth,	12,141	-	11,596,979	52	49	49
Webster,	11,509	-	10,206,433	56	53	50
Methuen,	11,448	-	6,675,090	77	61	51
Wakefield,	11,404	-	9,671,533	57	52	52
Arlington,	11,187	-	12,040,688	67	54	53
Greenfield,	10,427	-	10,483,859	68	57	54
Winthrop,	10,132	-	12,219,155	137	74	55
Amesbury,	-	9,894	6,352,115	39	51	56
Natick,	9,866	-	8,225,368	42	50	57
North Attleborough,	9,562	-	7,004,337	58	63	58
Danvers,	-	9,407	6,528,501	50	55	59
Winchester,	9,309	-	13,826,399	73	64	60
Dedham,	9,284	-	14,247,994	54	62	61
West Springfield,	9,224	-	7,305,002	71	65	62
Northbridge,	8,807	-	5,573,724	82	67	63
Ware,	8,774	-	5,281,108	51	56	64
Palmer,	8,610	-	4,389,877	59	58	65
Athol,	8,536	-	4,795,239	60	66	66
Easthampton,	8,524	-	5,975,370	92	80	67
Middleborough,	8,214	-	5,053,958	65	68	68
Braintree,	-	8,066	6,477,294	75	75	69
Saugus,	-	8,047	5,832,570	109	87	70

Table No. 7 — Continued.

City or Town.	Population in 1910.		Valuation, 1910.	Rank according to Population.		
	Places with Sewerage Systems.	Places without Sewerage Systems.		1890.	1900.	1910.
Norwood,	8,014	-	$14,510,576	107	82	71
Milton,	7,924	-	30,027,548	94	70	72
Bridgewater,	-	7,688	3,469,277	97	77	73
Marblehead,	-	7,338	8,165,136	47	60	74
Andover,	7,301	-	8,258,227	63	69	75
Whitman,	-	7,292	4,938,660	88	72	76
Stoneham,	7,090	-	5,182,026	62	71	77
Rockland,	-	6,928	4,234,547	69	86	78
Montague,	6,866	-	4,410,049	61	73	79
Hudson,	6,743	-	4,406,495	79	83	80
Spencer,	6,740	-	4,014,410	44	59	81
Concord,	6,421	-	7,810,410	91	79	82
Maynard,	6,390	-	3,884,701	138	133	83
Stoughton,	-	6,316	3,532,469	74	84	84
Swampscott,	6,204	-	11,274,093	117	101	85
Great Barrington,	5,926	-	6,270,783	81	76	86
Reading,	-	5,818	5,742,532	100	94	87
Ipswich,	-	5,777	5,150,855	89	97	88
Grafton,	-	5,705	2,954,956	72	95	89
Winchendon,	-	5,678	4,158,306	93	93	90
Blackstone,	-	5,648	2,271,572	64	78	91
Franklin,	5,641	-	3,922,637	76	91	92
Belmont,	5,542	-	6,854,544	166	113	93
North Andover,	5,529	-	5,211,428	106	108	94
Abington,	-	5,455	2,991,324	96	103	95
Westborough,	5,446	-	3,363,258	70	85	96
Wellesley,	-	5,413	15,322,124	111	88	97
Orange,	5,282	-	4,085,123	83	81	98
Mansfield,	-	5,183	4,092,054	113	110	99
Easton,	-	5,139	5,988,598	87	96	100
Fairhaven,	5,122	-	3,509,891	130	121	101
Amherst,	5,112	-	3,951,140	86	90	102
Needham,	-	5,026	6,143,578	123	109	103
Chelmsford,	-	5,010	4,615,068	139	112	104
Hingham,	-	4,965	6,930,664	84	89	105

Table No. 7 — Continued.

City or Town.	Population in 1910.		Valuation, 1910.	Rank according to Population.		
	Places with Sewerage Systems.	Places without Sewerage Systems.		1890.	1900.	1910.
Ludlow,	4,948	-	$3,991,012	177	123	106
Lexington,	-	4,918	8,640,266	118	114	107
South Hadley,	4,894	-	3,227,944	95	102	108
Walpole,	-	4,892	4,556,099	144	120	109
Canton,	-	4,797	4,603,931	85	100	110
Monson,	-	4,758	1,962,990	110	128	111
Millbury,	-	4,740	2,451,189	90	104	112
Barnstable,	-	4,676	6,221,967	102	106	113
Uxbridge,	-	4,671	3,069,637	114	118	114
Dartmouth,	-	4,378	4,249,897	121	117	115
Provincetown,	-	4,369	2,082,066	80	107	116
Randolph,	-	4,301	2,303,882	103	111	117
Dudley,	-	4,267	1,820,724	127	122	118
Rockport,	-	4,211	3,348,450	101	98	119
Warren,	-	4,188	2,063,147	78	105	120
Lee,	4,106	-	2,192,875	105	119	121
Wareham,	-	4,102	4,997,052	112	126	122
Foxborough,	-	3,863	2,294,432	128	130	123
Templeton,	-	3,756	1,752,055	125	125	124
Tewksbury,	-	3,750	1,341,886	149	116	125
Williamstown,	3,708	-	3,580,541	98	92	126
Dalton,	3,568	-	4,610,160	135	136	127
Hardwick,	3,524	-	2,013,791	129	132	128
Agawam,	-	3,501	2,011,454	153	149	129
Medfield,	3,466	-	1,900,642	209	139	130
Dracut,	-	3,461	2,329,492	173	131	131
East Bridgewater,	-	3,363	2,303,788	131	135	132
Oxford,	-	3,361	2,072,912	143	145	133
Leicester,	3,237	-	2,596,652	122	127	134
Falmouth,	-	3,144	9,563,560	146	124	135
Sutton,	-	3,078	1,307,877	119	129	136
North Brookfield,	3,075	-	1,707,572	104	99	137
Lenox,	3,060	-	6,335,406	134	138	138
Nantucket,	2,962	-	3,473,416	116	137	139
Barre,	-	2,957	1,908,838	156	172	140

Table No. 7 — Continued.

City or Town.	Population in 1910.		Valuation, 1910.	Rank according to Population.		
	Places with Sewerage Systems.	Places without Sewerage Systems.		1890.	1900.	1910.
Pepperell,	-	2,953	$2,316,594	120	115	141
Westport,	-	2,928	1,879,255	145	140	142
Westford,	-	2,851	2,344,168	155	146	143
Holbrook,	-	2,816	1,615,692	150	162	144
Somerset,	-	2,798	1,460,754	165	161	145
Ayer,	-	2,797	2,116,075	160	154	146
Billerica,	2,789	-	2,855,846	152	141	147
Holliston,	-	2,711	1,727,538	142	148	148
Medway,	-	2,696	1,453,664	126	142	149
Manchester,	-	2,673	16,947,227	189	150	150
Cohasset,	-	2,585	8,425,307	151	143	151
Norton,	-	2,544	1,250,499	191	186	152
Scituate,	-	2,482	4,635,042	154	152	153
Bourne,	-	2,474	4,395,415	214	202	154
Lancaster,	-	2,464	4,778,268	157	151	155
Hopkinton,	-	2,452	1,616,003	99	147	156
Kingston,	-	2,445	1,834,323	201	177	157
Auburn,	-	2,420	1,242,67	207	205	158
Seekonk,	-	2,397	1,283,490	224	200	159
Wilbraham,	-	2,332	1,215,648	187	209	160
Hanover,	-	2,326	1,619,814	167	164	161
Sharon,	-	2,310	2,824,364	203	171	162
Groveland,	-	2,253	1,175,229	158	155	163
Dighton,	-	2,235	1,143,556	182	190	164
West Bridgewater,	-	2,231	1,315,410	178	195	165
Deerfield,	-	2,209	1,885,442	132	175	166
Wayland,	-	2,206	2,542,454	170	159	167
Brookfield,	-	2,204	1,328,678	115	134	168
Merrimac,	-	2,202	1,297,240	140	165	169
Hopedale,	2,188	-	6,671,281	238	168	170
Groton,	-	2,155	4,283,327	171	174	171
Douglas,	-	2,152	1,347,893	179	167	172
Holden,	-	2,147	1,791,207	141	153	173
Shirley,	-	2,139	1,164,290	237	199	174
Acton,	-	2,136	2,167,930	181	166	175

Table No. 7 — Continued.

City or Town.	Population in 1910.		Valuation, 1910.	Rank according to Population.		
	Places with Sewerage Systems.	Places without Sewerage Systems.		1890.	1900.	1910.
Williamsburg,	-	2,132	$1,030,390	172	179	176
Harwich,	-	2,115	1,420,245	136	156	177
Ashburnham,	-	2,107	1,043,470	168	182	178
Weston,	-	2,106	8,748,609	200	185	179
Hull,	2,103	-	5,605,743	258	196	180
Upton,	-	2,071	1,154,040	183	178	181
Belchertown,	-	2,054	939,207	162	160	182
Charlton,	-	2,032	1,307,664	185	183	183
Avon,	-	2,013	979,471	218	194	184
Rehoboth,	-	2,001	871,950	190	184	185
Hadley,	-	1,999	1,377,976	199	191	186
Hatfield,	1,986	-	1,388,973	232	216	187
Swansea,	-	1,978	1,824,445	211	203	188
Georgetown,	-	1,958	1,028,318	163	181	189
Sturbridge,	-	1,957	1,069,508	169	173	190
Shrewsbury,	-	1,946	1,800,536	213	204	191
Stockbridge,	1,933	-	4,502,608	161	169	192
Dennis,	-	1,919	1,347,057	133	157	193
Wilmington,	-	1,858	1,465,908	235	208	194
Hanson,	-	1,854	1,129,912	230	221	195
Sheffield,	-	1,817	1,114,546	175	188	196
Townsend,	-	1,761	1,332,153	193	189	197
Hamilton,	-	1,749	4,419,559	264	206	198
Southborough,	-	1,745	3,016,516	164	180	199
Rutland,	-	1,743	719,110	261	230	200
Wrentham,	-	1,743	1,233,618	147	144	201
Colrain,	-	1,741	744,031	198	193	202
Marshfield,	-	1,738	2,002,795	196	187	203
Raynham,	-	1,725	854,541	221	213	204
Northborough,	-	1,713	1,395,575	176	163	205
Bellingham,	-	1,696	895,813	222	197	206
Acushnet,	-	1,692	805,519	249	236	207
Duxbury,	-	1,688	2,308,400	180	170	208
Sandwich,	-	1,688	1,057,182	186	223	209
Ashland,	-	1,682	1,210,363	148	214	210

Table No. 7 — Continued.

CITY OR TOWN.	POPULATION IN 1910.		Valuation, 1910.	RANK ACCORDING TO POPULATION.		
	Places with Sewerage Systems.	Places without Sewerage Systems.		1890.	1900.	1910.
Carver,	-	1,663	$1,530,950	257	250	211
Salisbury,	-	1,658	890,717	225	211	212
Northfield,	-	1,642	1,415,903	184	176	213
Essex,	-	1,621	1,212,445	195	201	214
Buckland,	-	1,573	721,143	205	225	215
Chatham,	-	1,564	1,286,607	174	192	216
East Longmeadow,	-	1,553	711,908	-	240	217
Cheshire,	-	1,508	830,342	226	237	218
Shelburne,	-	1,498	1,310,114	206	215	219
Newbury,	-	1,482	1,308,349	215	207	220
Huntington,	-	1,478	638,778	217	219	221
West Newbury,	-	1,473	1,130,571	188	212	222
Freetown,	-	1,471	986,314	216	227	223
Marion,	1,460	-	4,777,715	283	277	224
Sherborn,	-	1,428	1,552,583	219	218	225
Yarmouth,	-	1,420	2,410,192	192	198	226
Norwell,	-	1,410	1,090,735	202	210	227
Millis,	-	1,399	1,107,323	294	254	228
Lunenburg,	-	1,393	1,131,246	241	231	229
Plainville,	-	1,385	794,020	-	-	230
Chester,	-	1,377	741,616	228	222	231
Rowley,	-	1,368	769,376	231	228	232
Sterling,	-	1,359	1,151,538	233	226	233
Westminster,	-	1,353	847,667	197	232	234
Pembroke,	-	1,336	997,428	223	234	235
West Brookfield,	-	1,327	964,995	204	224	236
West Stockbridge,	-	1,271	446,220	210	242	237
West Boylston,	-	1,270	786,860	124	158	238
Westwood,	-	1,266	2,741,179	-	249	239
Mattapoisett,	-	1,233	1,936,080	240	253	240
Bedford,	-	1,231	1,449,334	244	239	241
Conway,	-	1,230	727,813	212	220	242
Littleton,	-	1,229	1,115,794	251	241	243
Clarksburg,	-	1,207	266,381	278	274	244
Tisbury,	-	1,196	1,602,750	208	245	245

Table No. 7 — Continued.

CITY OR TOWN.	POPULATION IN 1910.		Valuation, 1910.	RANK ACCORDING TO POPULATION.		
	Places with Sewerage Systems.	Places without Sewerage Systems.		1890.	1900.	1910.
Edgartown,	-	1,191	$1,230,121	239	238	246
Nahant,	1,184	-	8,076,496	279	243	247
Lincoln,	-	1,175	3,520,205	259	247	248
Topsfield,	-	1,174	1,429,710	252	259	249
Erving,	-	1,148	1,051,321	263	269	250
Lakeville,	-	1,141	720,555	268	270	251
Middleton,	-	1,129	832,913	269	282	252
New Marlborough,	-	1,124	719,494	227	233	253
Sudbury,	-	1,120	1,303,166	236	244	254
Hinsdale,	-	1,116	596,959	194	217	255
Stow,	-	1,115	956,940	274	263	256
Rochester,	-	1,090	667,863	255	266	257
Oak Bluffs,	1,084	-	1,827,603	245	251	258
Longmeadow,	1,084	-	1,502,854	159	285	259
Orleans,	-	1,077	688,122	234	248	260
Hubbardston,	-	1,073	702,235	220	235	261
North Reading,	-	1,059	731,082	281	258	262
Sunderland,	-	1,047	506,690	305	294	263
Harvard,	-	1,034	1,353,506	243	246	264
Wellfleet,	-	1,022	1,238,537	229	265	265
Southwick,	-	1,020	694,768	272	256	266
Wenham,	-	1,010	2,787,026	276	281	267
Charlemont,	-	1,001	528,663	262	252	268
Berkley,	-	999	419,691	275	273	269
Russell,	-	965	743,263	280	287	270
Norfolk,	-	960	855,701	273	267	271
Ashfield,	-	959	651,872	250	272	272
Becket,	-	959	527,430	267	264	273
Lanesborough,	-	947	529,352	253	291	274
Gill,	-	942	475,157	265	260	275
Lynnfield,	-	911	800,196	293	278	276
Berlin,	-	904	562,307	277	262	277
Ashby,	-	885	773,888	289	279	278
Mendon,	-	880	757,307	270	276	279
Enfield,	-	874	730,859	266	257	280

Table No. 7 — Continued.

City or Town.	Population in 1910.		Valuation, 1910.	Rank according to Population.		
	Places with Sewerage Systems.	Places without Sewerage Systems.		1890.	1900.	1910.
Southampton,	-	870	$501,659	254	261	281
Brimfield,	-	866	560,079	242	275	282
Whately,	-	846	484,024	295	296	283
Tyngsborough,	-	829	593,866	306	292	284
Princeton,	-	818	1,300,734	260	268	285
Dover,	-	798	5,738,416	300	306	286
Royalston,	-	792	646,519	248	271	287
Granville,	-	781	480,338	246	255	288
Bolton,	-	764	500,181	288	295	289
Granby,	-	761	517,006	298	298	290
Petersham,	-	757	949,548	247	280	291
Bernardston,	-	741	476,784	296	288	292
Dana,	-	736	403,751	303	289	293
Leverett,	-	728	319,792	302	301	294
Boxford,	-	718	1,439,079	284	302	295
Blandford,	-	717	543,592	282	283	296
Boylston,	-	714	485,022	297	229	297
Truro,	-	655	382,488	271	297	298
Richmond,	-	650	387,293	291	303	299
Hampden,	-	645	377,961	287	290	300
New Salem,	-	639	374,674	285	286	301
Cummington,	-	637	338,921	292	300	302
Brewster,	-	631	671,144	256	284	303
Egremont,	-	605	485,464	286	299	304
Burlington,	-	591	628,898	307	309	305
Worthington,	-	569	355,341	301	304	306
Sandisfield,	-	566	341,085	290	305	307
Plympton,	-	561	378,223	311	319	308
Oakham,	-	552	382,937	299	310	309
Carlisle,	-	551	524,114	326	320	310
Halifax,	-	550	542,205	316	312	311
Chesterfield,	-	536	319,022	309	308	312
Eastham,	-	518	450,951	310	315	313
Savoy,	-	503	189,621	314	314	314

Table No. 7 — Continued.

City or Town.	Population in 1910.		Valuation, 1910.	Rank according to Population.		
	Places with Sewerage Systems.	Places without Sewerage Systems.		1900.	1905.	1910.
Wendell,	-	502	$261,472	321	317	315
Otis,	-	494	278,101	312	321	316
Warwick,	-	477	437,072	315	307	317
Pelham,	-	467	288,902	325	323	318
Hancock,	-	465	316,242	320	326	319
New Braintree,	-	464	408,637	313	316	320
Rowe,	-	456	195,406	317	311	321
Greenwich,	-	452	255,252	318	318	322
West Tisbury,	-	437	608,682	-	327	323
Phillipston,	-	426	290,313	323	329	324
Hawley,	-	424	167,218	319	330	325
Westhampton,	-	423	246,043	327	322	326
Paxton,	-	416	334,528	330	324	327
Dunstable,	-	408	383,556	334	331	328
Plainfield,	-	406	178,317	332	333	329
Windsor,	-	404	279,326	308	313	330
Florida,	-	395	192,832	331	334	331
Monterey,	-	388	320,602	324	325	332
Tyringham,	-	382	268,462	335	335	333
Leyden,	-	363	174,327	336	338	334
Middlefield,	-	354	188,908	328	332	335
Heath,	-	346	172,608	322	328	336
Wales,	-	345	291,935	304	293	337
Prescott,	-	320	187,046	338	337	338
Boxborough,	-	317	268,562	340	341	339
Chilmark,	-	282	317,406	339	340	340
Goshen,	-	279	252,904	344	342	341
Washington,	-	277	278,834	333	339	342
Alford,	-	275	190,145	343	347	343
Mashpee,	-	270	216,282	342	344	344
Shutesbury,	-	267	258,947	329	336	345
Monroe,	-	246	172,007	345	343	346
Peru,	-	237	140,187	341	348	347
Montgomery,	-	217	169,074	346	346	348

Table No. 7 — Concluded.

CITY OR TOWN.	POPULATION IN 1910.		Valuation, 1910.	RANK ACCORDING TO POPULATION.		
	Places with Sewerage Systems.	Places without Sewerage Systems.		1890.	1900.	1910.
Tolland, ...	-	180	$198,819	337	345	349
Gay Head, ...	-	162	30,864	349	349	350
Gosnold, ...	-	152	581,341	350	351	351
Holland, ...	-	145	98,541	347	350	352
Mount Washington, . . .	-	110	92,144	348	352	353
New Ashford, ...	-	92	50,251	351	353	354

FOOD AND DRUG INSPECTION.

FOOD AND DRUG INSPECTION.

The report of the chief analyst presents in detail the work of this department for the year ended Nov. 30, 1911. The following personnel comprised the laboratory force: —

HERMANN C. LYTHGOE,	*Chief Analyst.*	HORACE F. DAVIS,	*Inspector.*
CHARLES H. HICKEY,	*First Asst. Analyst.*	DANIEL E. McCARTHY,	*Inspector.*
LEWIS I. NURENBERG,	*Second Asst. Analyst.*	FREDERICK L. MARION,	*Inspector.*
CLARENCE E. MARSH,	*Third Asst. Analyst.*	MAURICE P. CROWE,	*Inspector.*

The number of samples examined during this period, together with a summary of work done since the passage of the law in 1882, follows: —

Food and Drug Inspection (1882–1911).

SUMMARY.	YEARS.	
	1911.	Total 1882–1911.
Number of samples of milk examined,	4,690	115,694
Number of samples above standard,	3,777	76,228
Number of samples below standard,	913	39,466
Number of samples of other kinds of food examined (not milk),	1,479	67,660
Number of samples of good quality,	1,128	55,106
Number of samples adulterated, as defined by the statutes,	351	12,554
Number of samples of drugs examined,	1,114	22,354
Number of samples of good quality,	896	14,853
Number of samples adulterated, as defined by the statutes,	218	7,501
Total examination of food and drugs,	7,283	205,708
Total samples of good quality,	5,801	146,187
Total samples not conforming to the statutes,	1,482	59,521

Section 7 of chapter 75 of the Revised Laws provides that the State Board of Health "shall annually report to the general court the number of prosecutions made under the provisions of sections sixteen to twenty-seven, inclusive, and an itemized account of the money expended in carrying out the provisions thereof;" and in accordance with this provision the following report is made.

The total number of prosecutions entered during the fiscal year ended Nov. 30, 1911, was 161. Of these, 147 resulted in conviction, 9 in acquittal; 1 was nol-prossed; 3 were dismissed for want of prosecution; and 1 was dismissed by order of the court. There are 12 cases pending on appeal to the Superior Court.

The amount paid in fines was $4,015.91, which brings the sum total to $88,154.64.

PROSECUTIONS.

The following table presents the statistics relative to the prosecutions which have been conducted under the food and drug acts since the beginning of work in 1883 (Revised Laws, chapter 75, sections 16 to 27): —

Number of Complaints entered in Court.

YEAR.	Food and Other Articles (not including Milk).	Drugs.	Milk.	Total.	Convictions.	Fines imposed.
1883,	–	5	4	9	8	–[1]
1884,	2	1	45	48	44	–[1]
1885,[2]	50	1	68	119	103	–[1]
1886,[3]	10	–	10	20	19	–[1]
1887,	30	–	34	64	60	–[1]
1888,	22	–	43	65	61	$2,042 00
1889,	74	–	66	140	124	3,889 00
1890,	78	–	24	102	96	3,919 00
1891,	96	5	49	150	135	2,668 00
1892,	52	12	72	136	123	3,661 70
1893,	26	3	67	96	92	2,476 00
1894,	14	–	76	90	77	2,625 00
1895,	13	11	68	92	86	2,895 30
1896,	7	–	68	75	74	2,812 20
1897,	13	1	51	65	64	2,756 60
1898,	10	–	54	64	62	2,060 98
1899,	19	2	26	47	45	1,432 66
1900,	45	5	44	94	89	1,890 70
1901,	30	–	65	95	90	1,874 70
1902,	25	3	48	76	74	2,617 98
1903,	34	1	44	79	70	1,297 66
1904,	6	6	50	62	57	1,509 00
1905,	209	27	77	313	275	8,486 00
1906,[4]	177	60	171	409	383	7,316 00
1907,	123	63	147	333	290	6,546 00
1908,	76	138	219	433	386	8,300 30
1909,	72	44	180	296	267	5,666 74
1910,	112	26	119	257	244	5,395 21
1911,	49	30	82	161	147	4,015 91

[1] No record kept.

[2] To May 1, 1886.

[3] Four months only.

[4] Fourteen months, from Sept. 30, 1905.

The nature of the offences brought to the attention of the courts during the year, the names of the defendants, the places where the offences were committed, the dates of trial or indictment, and the results of the prosecutions, are set forth in the following table: —

For Sale of Milk not of Good Standard Quality.

Name.	Place.	Percentage of Total Solids.	Date.	Result.
Gorman, Edward J.,	Abington,	10.20[1]	May 10, 1911	Conviction.
Lovell, Walter,	Abington,	9.76[1]	May 10, 1911	Conviction.[2]
Hanscom, Wm. T.,	Bolton,	11.30[1]	Aug. 23, 1911	Conviction.
Hood, H. P. & Sons,	Cambridge,	10.78[3]	Feb. 1, 1911	Acquittal.
Wotton, James S.,	Chelmsford,	5.70[1]	Feb. 3, 1911	Conviction.
Barboya, Joseph M.,	Dartmouth,	9.20[1]	Aug. 26, 1911	Conviction.[2]
Szala, Andrew,	Dartmouth,	10.13[1]	Aug. 19, 1911	Conviction.
Andrews, Walter,	Dracut,	9.64[1]	Mar. 7, 1911	Conviction.
Andrews, Walter,	Dracut,	9.14[1]	Mar. 7, 1911	Conviction.
Best, Amos P.,	Dracut,	9.92[1]	Mar. 7, 1911	Conviction.
Best, Amos P.,	Dracut,	11.72[1]	Sept. 12, 1910	Conviction.
Derby, Daniel,	Dracut,	9.80[4]	Jan. 6, 1911	Conviction.
Derby, Daniel,	Dracut,	9.60[4]	Dec. 30, 1910	Conviction.
Ballard, Leonidas,	Dudley,	4.70[1,3]	Feb. 9, 1911	Conviction.
Ballard, Leonidas,	Dudley,	6.50[1,4]	Feb. 9, 1911	Conviction.
Dugdale, Richard,	Fairhaven,	10.66[1]	Aug. 19, 1911	Conviction.
Dolloff, Gardner,	Fitchburg,	10.90[1]	June 23, 1911	Conviction.
Stone, Samuel E.,	Fitchburg,	10.66[1]	May 17, 1911	Conviction.[2]
Kent, Walter G.,	Franklin,	11.17[1]	May 11, 1911	Conviction.
Powell, John D.,	Franklin,	9.16[3]	May 11, 1911	Conviction.
Powell, John D.,	Franklin,	11.17[1]	May 11, 1911	Conviction.
Lowenstien, Julius L.,	Hinsdale,	11.44[1]	June 2, 1911	Conviction.
Shaw, Thomas H.,	Holliston,	9.84[1]	July 14, 1911	Conviction.
Baben, John,	Hudson,	11.58[3]	Aug. 23, 1911	Conviction.
Shockley, Wm. E.,	Kingston,	9.48[1]	Jan. 28, 1911	Acquittal.
Sturgis, Frank,	Lanesborough,	11.84[3]	June 23, 1911	Conviction.
Sykes, Comfort,	Lanesborough,	9.16[3]	June 9, 1911	Conviction.
Sykes, Comfort,	Lanesborough,	10.68[1]	June 9, 1911	Conviction.
Zappla, Alefeũ,	Lawrence,	10.09[1]	Mar. 3, 1911	Dismissed.[5]
Cornelius, Louis W.,	Lenox,	13.00[1]	Oct. 20, 1911	Conviction.
Drew, Wallace,	Lowell,	12.36[3]	Jan. 6, 1911	Conviction.

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[1] Addition of water alleged in complaint.

[2] Appealed to upper court; case pending.

[3] Removal of cream alleged in complaint.

[4] Skimmed milk; cans not marked.

[5] Dismissed for want of prosecution.

For Sale of Milk not of Good Standard Quality — Continued.

Name.	Place.	Percentage of Total Solids.	Date.	Result.
Haley, John C.,	Lowell,	11.90[1]	Dec. 30, 1910	Conviction.
Nickles, Ralph C.,	Lowell,	10.67[2]	Jan. 6, 1911	Conviction.
Nickles, Ralph C.,	Lowell,	11.67[1]	Jan. 6, 1911	Conviction.
Bouyotis, Daniel,	Lynn,	10.45[1]	July 18, 1911	Conviction.
Finkel, Morris,	Lynn,	11.28[2]	Oct. 26, 1911	Conviction.
Heffion, Darwin F.,	Lynn,	10.88[2]	Jan. 21, 1911	Conviction.
Schmidgall, Gustav,	Lynn,	11.70[1]	Jan. 21, 1911	Conviction.
Nichols, Edward E.,	Malden,	11.70	Aug. 31, 1911	Conviction.
Martin, Knott V.,	Marblehead,	10.82	July 29, 1911	Conviction.
Martin, Stephen C.,	Marblehead,	10.22	July 29, 1911	Conviction.
Este, Frank F.,	Marlborough,	10.40[1]	May 6, 1911	Conviction.
Russo, James,	Maynard,	10.28[1]	Aug. 24, 1911	Conviction.
Russo, James,	Maynard,	10.10[2]	Aug. 24, 1911	Conviction.
Simonian, Charles,	Methuen,	10.41[2]	Mar. 24, 1911	Conviction.
Baker, Maurice W.,	Millis,	10.30[2]	Feb. 11, 1911	Conviction.
Balser, Theodore,	Natick,	11.05[2]	July 9, 1911	Conviction.
Woodward, Charles E.,	Natick,	10.04[3]	July 10, 1911	Conviction.
Madeiro, Virgin P.,	New Bedford,	9.40[2]	Aug. 26, 1911	Conviction.
Sage, Charles D.,	New Braintree,	10.83	July 10, 1911	Acquittal.
Bingeil, Charles,	Newton,	11.18[1]	Apr. 14, 1911	Conviction.
Cunningham, John A.,	Newton,	12.24[2]	Dec. 29, 1910	Conviction.
Cunningham, John A.,	Newton,	12.24[1]	Dec. 29, 1910	Conviction.
Doherty, Patrick,	North Andover,	9.60[2]	June 30, 1911	Conviction.
Doherty, Patrick,	North Andover,	8.93[2]	June 30, 1911	Conviction.
Golden, William,	North Attleborough,	11.40[2]	May 16, 1911	Conviction.
Nielsen, Hans,	Oxford,	9.94[2]	Feb. 9, 1911	Conviction.
Benz, John C.,	Pittsfield,	9.17[2]	Oct. 27, 1911	Conviction.[4]
Jones, Wm. S.,	Pittsfield,	11.46[2]	May 2, 1911	Conviction.
Kirchner, Henry,	Pittsfield,	11.34[1]	Sept. 8, 1911	Conviction.
Rice, Robert A.,	Pittsfield,	11.26[2]	Sept. 8, 1911	Conviction.
Sykes, George W.,	Pittsfield,	10.76[1]	Oct. 13, 1911	Acquittal.
Wehry, Frank,	Pittsfield,	12.10[2]	Oct. 13, 1911	Conviction.
Proctor, Irving,	Princeton,	8.40[2]	Mar. 22, 1911	Conviction.
Nickerson, Lemuel F.,	Provincetown,	11.64[2]	Sept. 6, 1911	Conviction.
Steele, Joseph,	Provincetown,	11.84[2]	Sept. 6, 1911	Conviction.

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[1] Removal of cream alleged in complaint.

[2] Addition of water alleged in complaint.

[3] Skimmed milk; cans not marked.

[4] Appealed to upper court; case pending.

For Sale of Milk not of Good Standard Quality — Concluded.

NAME.	Place.	Percentage of Total Solids.	Date.	Result.
Nowland, James M.,	Quincy,	11.30[1]	Mar. 31, 1911	Conviction.
Pitrongelie, Gaspee,	Quincy,	11.35[1]	Mar. 31, 1911	Conviction.
Wakefield, Wm. H.,	Spencer,	9.20[2]	June 15, 1911	Conviction.
Gissin, Morris,	Springfield,	9.50[1]	July 6, 1911	Conviction.[3]
Banville, Joseph E.,	Swansea,	11.62[1]	Feb. 24, 1911	Conviction.
Chace, Charles H.,	Swansea,	9.30[1]	Feb. 24, 1911	Conviction.
Hoffman, Paul,	Taunton,	11.72[1]	Sept. 2, 1911	Conviction.
Cooper, Wm. A.,	Townsend,	11.80[1]	July 11, 1911	Conviction.
Nason, Albert L.,	Upton,	9.76[1]	Sept. 12, 1911	Nol-prossed.
Perrott, Saml. L.,	Waltham,	10.00	June 26, 1911	Conviction.
Rynn, John,	Wayland,	11.47[2]	July 24, 1911	Conviction.[3]
Foster, Orlando A.,	Westford,	10.40[1]	May 15, 1911	Acquittal.
Day, John,	Winchester,	12.36[1]	Nov. 2, 1911	Conviction.
Bennett, Matthew J.,	Woburn,	11.69[4]	Dec. 31, 1910	Conviction.
Winn, G. Edward,	Woburn,	10.24[1]	Sept. 16, 1911	Conviction.
Winn, G. Edward,	Woburn,	10.12[1]	Sept. 16, 1911	Conviction.

[1] Addition of water alleged in complaint.
[2] Skimmed milk; cans not marked.
[3] Appealed to upper court; case pending.
[4] Removal of cream alleged in complaint.

For Sale of Adulterated Cream.

NAME.	Place.	Adulterant.	Date.	Result.
Kent, Walter G.,	Franklin,	Formaldehyde,	May 11, 1911	Conviction.
Powell, John D.,	Franklin,	Formaldehyde,	May 11, 1911	Conviction.

For Sale of Oleomargarine as Butter.

NAME.	Place.	Date.	Result.
Chase, Samuel F.,	Fall River,	Dec. 20, 1910	Conviction.
Bouyotis, Daniel,	Lynn,	July 18, 1911	Conviction.

For Sale of Adulterated Foods Other than Milk and Milk Products.

LARD.

NAME.	Place.	Adulterant.	Date.	Result.
Silverman, Joseph,	Lawrence,	Cotton-seed oil,	Mar. 3, 1911	Conviction.
White, James,	Lowell,	Cotton-seed oil,	May 26, 1911	Conviction.
Martin, George E.,	Westford,	Cotton-seed oil,	Jan. 27, 1911	Conviction.

SAUSAGE.

Ryder, Frank,	Boston,	Cereal,	Jan. 5, 1911	Conviction.
Loranger, Zephiren,	Lowell,	Cereal,	Feb. 17, 1911	Conviction.
Loranger, Zephiren,	Lowell,	Cereal,	Feb. 17, 1911	Conviction.

LIVER SAUSAGE.

Winer, Abraham,	Boston,	Cereal,	Apr. 11, 1911	Conviction.

PORK SAUSAGE.

Gunsenheiser, Abraham,	Boston,	Cereal,	Aug. 17, 1911	Conviction.[1]
Rand, Fred B.,	Boston,	Cereal,	Apr. 27, 1911	Conviction.
Redican, James J.,	Boston,	Cereal,	Apr. 25, 1911	Conviction.
Schapp, C. L.,	Boston,	Cereal,	Mar. 30, 1911	Conviction.
Siegel Co., Henry,	Boston,	Cereal,	Mar. 30, 1911	Conviction.
Sullivan, Jerome,	Boston,	Cereal,	Apr. 25, 1911	Conviction.
Tansey, James,	Boston,	Cereal,	Mar. 30, 1911	Conviction.
Walter, Samuel B.,	Boston,	Cereal,	Apr. 11, 1911	Conviction.
Harris, Wm. H.,	Lawrence,	Cereal,	Mar. 3, 1911	Conviction.
Marshall, Herbert,	Lawrence,	Cereal,	Mar. 3, 1911	Conviction.
Reeves, Peter,	Lawrence,	Cereal,	Mar. 3, 1911	Conviction.
Rogers, Merton T.,	Lawrence,	Cereal,	Mar. 3, 1911	Conviction.
Yunggebauer, Gustav A.,	Lawrence,	Cereal,	Mar. 3, 1911	Conviction.
Zajicek, John F.,	Lawrence,	Cereal,	Apr. 7, 1911	Conviction.
Cognac, Oscar P.,	Lowell,	Cereal,	May 26, 1911	Conviction.
Adams, James,	Springfield,	Cereal,	Apr. 21, 1911	Acquittal.
Ibey, George,	Springfield,	Cereal,	Apr. 21, 1911	Acquittal.

TOMATO SAUSAGE.

Kelly, Daniel W.,	Boston,	Cereal,	Apr. 27, 1911	Conviction.

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[1] Appealed to upper court; case pending.

For Sale of Adulterated Foods Other than Milk and Milk Products — Continued.

TRIPE.

NAME.	Place.	Adulterant.	Date.	Result.
Phipps, Harry, . . .	Framingham, .	Boron compound, .	Mar. 11, 1911	Conviction.

MAPLE SUGAR.

NAME.	Place.	Adulterant.	Date.	Result.
Capobianco, Daniel, . .	Boston, . .	Cane sugar, . . .	Apr. 27, 1911	Conviction.
Caradontes, Thomas, .	Boston, . .	Cane sugar, . .	June 29, 1911	Conviction.[1]
Cunio, Charles, . . .	Lawrence, .	Cane sugar, . .	Mar. 3, 1911	Conviction.

PICKLES.

NAME.	Place.	Adulterant.	Date.	Result.
Lord, Herbert C., . .	Malden, . .	Alum, ...	Jan. 10, 1911	Conviction.

CIDER.

NAME.	Place.	Adulterant.	Date.	Result.
Cannon, Thomas F., . .	Boston, . .	Benzoic acid, . .	Feb. 8, 1911	Conviction.
Capobianco, Daniel, . .	Boston, . .	Benzoic acid, . .	Apr. 27, 1911	Conviction.
Bliss, Geo. W., . . .	Fall River, .	Benzoic acid, . .	Dec. 20, 1910	Conviction.
Lapos, John, . . .	Melrose, . .	Benzoic acid, . .	Feb. 7, 1911	Conviction.
Russo, Michele, . . .	Melrose, . .	Benzoic acid, . .	Feb. 7, 1911	Acquittal.

CIDER VINEGAR.

NAME.	Place.	Adulterant.	Date.	Result.
Frumerin, Peter, . .	Brockton, .	Water, ...	Oct. 28, 1911	Conviction.
Gilson, Clarence M., . .	Brockton, .	Not cider vinegar, .	Oct. 17, 1911	Conviction.

OLIVE OIL.

NAME.	Place.	Adulterant.	Date.	Result.
Zika, John, . . .	Natick, . .	Cotton-seed oil, . .	June 3, 1911	Conviction.

BROKEN-OUT EGGS.

NAME.	Place.	Adulterant.	Date.	Result.
Shwer, Max, . . .	Boston, . .	Decomposed, . .	Oct. 11, 1911	Conviction.

COFFEE EXTRACT.

NAME.	Place.	Adulterant.	Date.	Result.
The Goodwin Co., . .	Cambridge, .	Benzoic acid, . .	Jan. 30, 1911	Conviction.

EXTRACT OF LEMON.

NAME.	Place.	Adulterant.	Date.	Result.
Bliss, Harry A., . .	Salem, . .	Wood alcohol and water.	May 12, 1911	Conviction.

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[1] Appealed to upper court; case pending.

For Sale of Adulterated Foods Other than Milk and Milk Products — Concluded.

EXTRACT OF VANILLA.

NAME.	Place.	Adulterant.	Date.	Result.
Bliss, Harry A.,	Salem,	Wood alcohol,	May 12, 1911	Conviction.

VINEGAR.

NAME.	Place.	Adulterant.	Date.	Result.
The Fleischman Co.,	Boston,	Contains coloring matter.	Apr. 7, 1911	Conviction.[1]
The Fleischman Co.,	Fall River,	Contains coloring matter.	May 9, 1911	Conviction.[1]

YEAST.

NAME.	Place.	Adulterant.	Date.	Result.
Trainor, John J.,	Boston,	Tapioca starch,	Mar. 14, 1911	Conviction.[1]

For Sale of Adulterated Drugs.

DENATURED ALCOHOL.

NAME.	Place.	Adulterant.	Date.	Result.
Brown, Harold S.,	Boston,	Wood alcohol,	Mar. 21, 1911	Conviction.
Cardinal, Louis L.,	Boston,	Not labeled,	May 4, 1911	Conviction.
Doherty, Henry J.,	Boston,	Wood alcohol,	Sept. 15, 1911	Conviction.
McAuley, James A.,	Boston,	Wood alcohol,	Apr. 27, 1911	Conviction.
Maxwell, Roy W.,	Boston,	Wood alcohol; not correctly marked.	Mar. 21, 1911	Conviction.[1]
Siegel Co., Henry,	Boston,	Wood alcohol,	Dec. 9, 1910	Conviction.
Watchell, Benj. W.,	Boston,	Not correctly marked,	Mar. 21, 1911	Conviction.
Hosie, Horace W.,	Franklin,	Wood alcohol; not labeled.	July 8, 1911	Conviction.
Walton, Eben A.,	Franklin,	Wood alcohol; not labeled.	July 8, 1911	Conviction.
Doyle, Michael T.,	Lawrence,	Wood alcohol; not correctly marked.	Mar. 3, 1911	Conviction.
Keating, Walter J.,	Lawrence,	Not correctly marked,	Mar. 3, 1911	Conviction.
Carley, Columbus G.,	Newton,	Wood alcohol; not correctly marked.	Feb. 13, 1911	Conviction.
Cushman, John T.,	Newton,	Wood alcohol; not correctly marked.	Feb. 13, 1911	Conviction.
Cushman, John T.,	Newton,	Wood alcohol; not correctly marked.	Feb. 13, 1911	Conviction.
Philbrick, Leroy B.,	Salem,	Wood alcohol; not correctly marked.	Mar. 2, 1911	Conviction.
Beauvais, Joseph H.,	Springfield,	Wood alcohol; not correctly marked.	Mar. 1, 1911	Dismissed.[2]

ANISE-SEED SYRUP.

NAME.	Place.	Adulterant.	Date.	Result.
Gauvin, Rosana A.,	Lowell,	Morphine,	Mar. 7, 1911	Conviction.

TINCTURE OF ARNICA.

NAME.	Place.	Adulterant.	Date.	Result.
Cicchetti, Quirino,	Boston,	Deficiency in strength,	May 18, 1911	Conviction.
Flynn, Cornelius P.,	Boston,	Deficiency in strength,	May 17, 1911	Acquittal.

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[1] Appealed to upper court; case pending.

[2] Dismissed for want of prosecution.

For Sale of Adulterated Drugs — Concluded.

CAMPHOR LINIMENT.

NAME.	Place.	Adulterant.	Date.	Result.
Cunningham, Alex. W.,	Springfield,	Deficiency in strength,	July 6, 1911	Conviction.

TINCTURE OF IODINE.

NAME.	Place.	Adulterant.	Date.	Result.
Kale, Maxie,	Boston,	Deficiency in strength,	Dec. 24, 1910	Conviction.

ESSENCE OF PEPPERMINT.

NAME.	Place.	Adulterant.	Date.	Result.
Wallenberg, Edward,	Boston,	Deficiency in strength,	Dec. 12, 1910	Conviction.

SPIRIT OF PEPPERMINT.

NAME.	Place.	Adulterant.	Date.	Result.
Conwell, Walter L.,	Boston,	Deficiency in strength,	July 19, 1911	Dismissed.[1]
Downey, Francis P.,	Boston,	Deficiency in strength,	Feb. 4, 1911	Conviction.
O'Connor, Michael J.,	Boston,	Deficiency in strength,	July 19, 1911	Conviction.
Roos, Samuel B.,	Boston,	Deficiency in strength,	Feb. 3, 1911	Dismissed.[2]
Cragin, Frank S.,	Lawrence,	Deficiency in strength,	June 20, 1911	Conviction.
Lord, Joseph F.,	Lawrence,	Deficiency in strength,	June 20, 1911	Conviction.

WOOD ALCOHOL.

NAME.	Place.	Adulterant.	Date.	Result.
Levy, Hyman J.,	Boston,	Not correctly marked,	Mar. 30, 1911	Conviction.
Karp, Samuel L.,	Boston,	Not correctly marked,	Aug. 30, 1911	Conviction.

[1] Dismissed by order of the court.

[2] Dismissed for want of prosecution.

Of the cases reported as pending in the last preceding report, 7 for the sale of adulterated milk resulted in conviction and fine and 1 was placed on file.

Two cases for the sale of milk in cans containing offensive material, pending in 1908, came to trial in the latter part of 1910 and were reported on in January, 1911. These 2 cases resulted in conviction and fine.

The amount paid in fines was $4,015.91, as follows: —

Milk and milk products,	$2,890 91
Foods other than above,	705 00
Drugs,	420 00
	$4,015 91

The total number of samples of food, drugs, liquors, poisons and oils examined during the year was as follows: —

Milk,	4,690
Food,	1,479
Drugs,	1,114
Liquors,	116
Poisons,	151
Linseed oil,	1
	7,551

EXPENDITURES UNDER THE PROVISIONS OF THE FOOD AND DRUG ACTS FOR THE YEAR ENDED Nov. 30, 1911.

Appropriation,	$17,500 00
Salaries of analysts,	$6,250 00
Salaries of inspectors,	5,398 22
Traveling expenses and purchase of samples,	3,296 91
Apparatus and chemicals,	1,371 61
Printing,	89 63
Services, cleaning laboratory,	104 00
Express and telephone,	13 57
Sundry laboratory supplies,	82 40
Books, binding and stationery,	178 80
Extra services,	13 00
Advertising,	10 50
Miscellaneous,	7 75
Total,	$16,816 39

REPORT OF THE ANALYST.

By **Hermann C. Lythgoe.**

REPORT OF THE ANALYST.

By Hermann C. Lythgoe.

Dr. Mark W. Richardson, *Secretary of the Massachusetts State Board of Health.*

Dear Sir: — I herewith submit my report on the anaylsis of food and drugs for the year ending Nov. 30, 1911.

Milk and Milk Products.

Four thousand six hundred and ninety samples of milk were examined during the year, of which 3,777 were above the legal standard. Two hundred and nine samples contained added water and 63 samples were skimmed without being properly labeled. Eleven samples of adulterated milk were above the legal standard. The usual statistics of milk are as follows: —

Milk from Cities and Towns.

Locality.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample (Per Cent.).	Number of Skimmed Samples.	Number of Watered Samples.
Abington,	3	3	6	9.96	1	–
Adams,	37	–	37	12.20	–	–
Andover,	12	3	15	11.92	–	–
Arlington,	31	10	41	10.60	–	2
Ashby,	7	3	10	9.92	1	–
Athol,	12	4	16	8.70	2	–
Attleborough,	66	2	68	11.34	1	–
Belmont,	5	–	5	13.20	–	–
BEVERLY,	56	2	58	11.10	–	–
Billerica,	3	2	5	11.64	–	–
Bradford,	7	–	7	13.20	–	–
Braintree,	17	1	18	12.00	–	–
Bridgewater,	13	–	13	9.70	1	–
BROCKTON,	130	31	161	11.18	–	1

Milk from Cities and Towns — Continued.

LOCALITY.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample (Per Cent.).	Number of Skimmed Samples.	Number of Watered Samples.
Brookline,	33	2	35	12.09	-	-
Burlington,	9	15	24	10.82	-	2
CAMBRIDGE,	97	8	105	10.78	-	-
CHELSEA,	79	6	85	11.72	-	-
CHICOPEE,	29	5	34	10.72	-	1
Clinton,	8	2	10	11.40	-	-
Dalton,	8	3	11	9.26	1	-
Dartmouth,	25	9	34	11.58	-	-
Dedham,	12	3	15	11.72	-	-
Dighton,	15	10	25	12.00	-	-
Edgartown,	26	15	41	10.90	-	5
EVERETT,	35	-	35	12.16	-	-
FALL RIVER,	75	15	90	9.11	-	4
Falmouth,	14	2	16	10.95	-	-
Fitchburg,	39	21	60	9.52	3	7
Franklin,	7	11	18	8.36	-	3
Framingham,	57	3	60	11.72	-	-
Gardner,	14	4	18	11.44	-	-
GLOUCESTER,	35	7	42	9.44	-	4
Great Barrington,	4	-	4	12.92	-	-
Greenfield,	15	-	15	12.16	-	-
Hadley,	14	1	15	11.90	-	-
Halifax,	3	3	6	11.30	-	-
HAVERHILL,	50	24	74	11.38	-	-
Hingham,	7	5	12	11.06	-	-
HOLYOKE,	23	9	32	7.68	-	1
Hudson,	9	4	13	11.30	-	2
Hyde Park,	48	7	55	11.80	-	-
Ipswich,	13	-	13	12.46	-	-
Kingston,	2	2	4	11.84	-	-
Lanesborough,	10	5	15	9.16	-	4
LAWRENCE,	169	58	227	8.93	1	16
Lenox,	11	1	12	11.96	-	1
Leominster,	21	4	25	11.52	-	-
Lexington,	8	4	12	11.75	-	-
Lincoln,	3	3	6	11.80	-	-

Milk from Cities and Towns — Continued.

LOCALITY.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample (Per Cent.).	Number of Skimmed Samples.	Number of Watered Samples.
Littleton,	9	1	10	11.50	-	-
LOWELL,	133	40	173	9.80	-	9
LYNN,	82	38	120	9.64	1	4
MALDEN,	54	10	64	11.70	-	-
Mansfield,	18	1	19	10.64	-	-
Marblehead,	17	4	21	10.22	-	3
MARLBOROUGH,	61	3	64	9.86	2	-
Maynard,	8	7	15	10.10	-	1
MEDFORD,	91	7	98	10.80	-	1
MELROSE,	24	1	25	9.68	1	-
Mendon,	5	5	10	10.62	-	-
Middleborough,	17	1	18	11.36	-	1
Milford,	69	21	90	8.90	-	1
Millbury,	23	8	31	10.46	-	-
Montague,	16	-	16	12.20	-	-
Natick,	27	5	32	10.04	1	1
NEW BEDFORD,	142	35	177	7.86	-	9
NEWBURYPORT,	47	1	48	9.50	1	-
NEWTON,	62	8	70	11.50	-	1
NORTH ADAMS,	41	-	41	12.28	-	-
NORTHAMPTON,	10	7	17	11.42	-	-
North Andover,	15	8	23	11.12	-	-
North Attleborough,	49	2	51	11.40	-	2
Northbridge,	34	5	39	9.16	1	-
Norwood,	9	-	9	12.44	-	-
Oak Bluffs,	8	1	9	11.66	-	-
Palmer,	13	4	17	9.14	1	-
Peabody,	43	4	47	11.90	-	-
PITTSFIELD,	157	32	189	9.00	4	9
Plymouth,	13	7	20	10.36	1	1
Provincetown,	8	3	11	11.64	-	3
QUINCY,	62	16	78	10.74	-	5
Randolph,	14	2	16	12.00	-	-
Reading,	46	2	48	12.00	-	-
Revere,	13	2	15	11.40	-	-
Rockland,	10	1	11	11.70	-	-

Milk from Cities and Towns — Concluded.

LOCALITY.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample (Per Cent.).	Number of Skimmed Samples.	Number of Watered Samples.
Rockport,	6	-	6	12.57	-	-
SALEM,	41	1	42	11.46	-	-
Saugus,	26	5	31	11.90	-	-
Shelburne,	10	-	10	12.16	-	-
Shirley,	6	3	9	11.88	-	-
SOMERVILLE,	72	21	93	11.11	-	-
Southbridge,	12	4	16	11.30	-	-
Spencer,	10	3	13	8.86	1	-
Springfield,	127	25	152	9.50	-	1
Stoneham,	15	9	24	9.20	1	-
Stoughton,	14	1	15	11.80	-	-
TAUNTON,	58	7	65	11.14	1	2
Upton,	3	5	8	9.76	-	2
Wakefield,	10	-	10	12.38	-	-
WALTHAM,	47	14	61	10.00	-	-
Ware,	18	2	20	12.00	-	-
Webster,	30	4	34	12.34	-	-
Wellesley,	13	-	13	12.20	-	-
Westborough,	13	4	17	11.22	-	-
West Boylston,	22	-	22	12.20	-	-
Westfield,	12	1	13	12.10	-	-
Weymouth,	27	-	27	12.32	-	-
Whitman,	21	2	23	11.84	-	-
Williamstown,	6	4	10	11.22	-	-
Winchester,	42	4	46	11.74	-	2
Winchendon,	13	1	14	11.90	-	-
Winthrop,	30	3	33	10.58	-	-
Woburn,	49	25	74	9.27	-	13
WORCESTER,	44	14	58	9.94	1	1
Totals,	3,672	787	4,459	7.68	28	125

Milk from Suspected Producers.

Locality.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample (Per Cent.).	Number of Watered Samples.
Ashburnham,	1	21	22	10.66	22
Fitchburg,	14	13	27	7.10	6
Holliston,	–	4	4	9.84	4
Leominster,	12	6	18	11.22	–
Lowell,	10	15	25	5.70	15
Lunenburg,	5	–	5	12.22	–
Methuen,	–	9	9	10.41	8
Millis,	–	10	10	10.30	10
New Braintree,	1	15	16	10.83	–
Northborough,	1	4	5	11.16	–
Oxford,	7	8	15	9.94	8
Princeton,	–	6	6	7.34	6
Rockland,	–	4	4	7.90	4
Swansea,	10	6	16	11.17	4
Townsend,	8	1	9	11.80	1
Westford,	–	4	4	10.36	–
Totals,	69	126	195	5.70	88

Summary of Milk Statistics.

Locality.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample (Per Cent.).	Number of Skimmed Samples.	Number of Watered Samples.
Milk from towns and cities,	3,672	787	4,459	7.68	28	125
Milk from suspected producers,	69	126	195	5.70	–	88
Miscellaneous milk samples,	36	–	36	12.21	–	–
Totals,	3,777	913	4,690	5.70	28	213

Milk containing Added Water.

DEALER.	LOCALITY.	Total Solids (Per Cent.).	Fat (Per Cent.)	Solids not Fat (Per Cent.).	Refraction of Copper Serum at 20° C.
W. F. Adams,	Fitchburg,	12.12	4.50	7.62	35.7
Zaphla Alefeu,	Lawrence,	10.36	3.05	7.31	34.6
		10.82	3.40	7.42	34.7
		10.20	3.00	7.20	34.2
		10.84	3.40	7.44	34.8
		10.70	3.40	7.30	34.5
		10.52	3.20	7.32	34.3
		10.09	3.10	6.99	33.7
Walter Andrews,	Dracut,	9.14	2.80	6.34	32.7
		9.64	3.00	6.64	33.7
Maurice W. Baker,	Millis,	11.80	3.80	8.00	35.7
		11.70	3.60	8.10	35.7
		11.70	3.60	8.10	35.6
		12.10	4.20	7.90	35.4
		11.90	3.90	8.00	35.4
		12.10	4.30	7.80	35.4
		12.06	4.10	7.96	35.7
		12.10	4.30	7.80	35.3
		11.73	2.80	7.92	35.6
		10.30	3.50	6.80	33.3
Joseph E. Banville,	Swansea,	11.62	3.95	7.67	34.8
Joseph M. Barboza,	South Dartmouth,	9.80	2.50	7.30	34.4
		9.20	2.30	6.90	33.6
John Benz,	Pittsfield,	9.17	2.00	7.17	33.5
Amos P. Best,	Lowell,	10.64	3.30	7.34	34.4
		10.61	3.30	7.31	34.4
		10.36	3.05	7.31	34.6
		10.20	3.00	7.20	34.5
		10.10	2.90	7.20	34.5
		10.16	2.90	7.26	34.5
		10.20	2.85	7.35	34.5
		10.17	2.90	7.27	34.5
		9.92	3.10	6.82	33.8
Theodore Bolser,	Natick,	11.05	3.30	7.75	35.5
W. Brown,	Lawrence,	10.86	3.00	7.86	35.2

Milk containing Added Water — Continued.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum at 20° C.
Abraham Buckley,	Millbury,	11.72	3.60	8.12	36.0
		11.52	3.50	8.02	35.8
		11.18	3.45	7.73	35.5
Joseph A. Carroll,	Upton,	8.90	2.50	6.40	32.0
Carter Brothers,	Gloucester,	10.56	3.00	7.56	35.0
		10.50	3.00	7.50	34.8
Charles H. Chace,	Swansea,	11.17	3.50	7.67	34.7
		11.87	3.90	7.97	36.3
		11.60	3.80	7.80	35.8
		9.30	3.00	6.30	32.5
Joseph Coon,	Chicopee,	10.74	3.20	7.54	34.2
Wm. A. Cooper,	Townsend Harbor,	11.80	4.20	7.60	34.5
Louis W. Cornelius,	Richmond,	13.00	4.90	8.10	35.3
John A. Cunningham,	Waltham,	12.28	4.30	7.98	35.4
George A. Cutting,	Fitchburg,	10.52	3.00	7.52	34.8
John Day,	Woburn,	12.36	4.15	8.21	35.7
Patrick Doherty,	North Andover,	8.93	2.40	6.53	33.7
		9.58	2.65	6.93	34.4
		10.46	3.10	7.36	34.8
		9.50	2.85	6.65	34.2
		9.60	2.80	6.80	33.8
		10.00	2.90	7.10	34.0
Gardner Dolloff,	Fitchburg,	11.90	4.00	7.90	35.2
		10.90	3.50	7.40	34.6
		11.78	4.00	7.78	35.0
Richard Dugdale,	Dartmouth,	10.66	3.10	7.56	34.7
		11.06	3.40	7.66	35.5
		11.22	3.40	7.82	35.6
		11.26	3.55	7.71	35.7
		11.26	3.60	7.66	35.7
Demetrius Economos,	Worcester,	10.36	2.80	7.56	35.1
Henry Finger,	Lanesborough,	12.10	4.10	8.00	36.2
Morris Finkel,	Lynn,	11.28	3.50	7.78	36.0
		11.28	3.50	7.78	36.0

Milk containing Added Water — Continued.

DEALER.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.)	Solids not Fat (Per Cent.).	Refraction of Copper Serum at 20° C.
Orlando A. Foster,	Westford,	10.66	3.20	7.46	35.2
		10.70	3.30	7.40	35.2
		10.36	3.30	7.06	34.7
		10.40	3.40	7.00	34.7
A. S. Furtado,	Fall River,	9.15	2.90	6.25	31.8
Archie Gingeas,	New Bedford,	10.86	3.00	7.86	35.2
Morris Gissin,	Springfield,	9.50	3.10	6.40	31.4
William Golden,	North Attleborough,	12.72	4.80	7.92	35.8
		11.40	3.65	7.76	35.7
Edward J. Gorman,	Abington,	10.20	3.10	7.10	34.3
John S. Gracie,	Dartmouth,	7.86	2.10	5.76	30.0
Thomas Greenwood,	New Bedford,	10.15	2.70	7.45	35.4
		10.46	3.30	7.16	35.4
Joseph H. Gregory,	Raynham,	11.14	3.60	7.54	35.5
S. Halp,	Lawrence,	10.48	3.00	7.48	34.7
		10.48	3.00	7.48	34.9
Walter T. Hanscom,	Bolton,	11.34	3.60	7.74	34.3
		11.30	3.50	7.80	34.5
Darwin F. Heffion,	Lynn,	10.88	3.20	7.68	35.5
Paul Hoffman,	Taunton,	11.72	3.95	7.77	35.4
John C. Hood,	Winchester,	11.37	3.90	7.47	35.1
		11.19	3.70	7.49	34.5
William S. Jones,	Pittsfield,	11.46	3.90	7.56	35.2
		11.50	4.00	7.50	35.2
Adam Kurtz,	Holyoke,	7.68	2.30	5.38	29.8
John D. Landers,	Lynn,	10.10	2.60	7.50	34.9
Walter Lovell,	Hanover,	7.90	3.00	4.90	31.0
		9.76	4.30	5.46	32.0
Lithuanian Co-operative Company,	Middleborough,	11.36	3.90	7.46	34.6
Julius L. Lowenstein,	Hinsdale,	11.16	4.20	6.96	34.2
		11.44	4.00	7.44	35.4
A. R. Macomber,	New Bedford,	11.16	3.60	7.56	35.8
Knott V. Martin, Henry E. Martin, Stephen C. Martin,	Marblehead,	10.82	3.30	7.52	35.3
		10.22	3.05	7.17	34.2

Milk containing Added Water — Continued.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum at 20° C.
Virgin P. Madeiros,	New Bedford,	10.10	2.75	7.35	35.0
		9.40	2.60	6.80	34.2
Albert L. Nason,	Upton,	9.76	3.20	6.56	32.9
		11.00	3.60	7.40	33.9
Ralph C. Nichols,	Lowell,	10.26	3.00	7.26	33.3
		10.36	3.00	7.36	33.4
		10.90	3.00	7.90	34.2
		10.60	3.20	7.40	33.7
		11.20	3.40	7.72	34.2
Lemuel F. Nickerson,	Provincetown,	11.64	3.90	7.74	35.3
Hans Nielson,	Oxford,	11.54	3.90	7.64	33.9
		10.26	3.10	7.16	32.9
		10.20	3.10	7.10	33.3
		10.20	3.20	7.00	33.2
		11.26	4.20	7.06	34.0
		9.94	3.10	6.84	32.4
		9.96	3.20	6.76	32.6
		10.04	3.20	6.84	32.6
James M. Nowland,	Quincy,	11.30	3.80	7.50	34.4
		11.44	4.00	7.44	34.6
		11.35	4.00	7.35	34.5
		11.55	4.00	7.55	34.6
L. W. Osborne,	Plymouth,	11.21	4.40	6.81	33.2
John D. Powell,	Woonsocket, R. I.,	10.74	3.20	7.54	35.4
		8.36	0.10	8.26	36.0
		11.17	3.60	7.57	35.7
Irving Proctor,	Princeton,	10.46	3.60	6.86	33.1
		10.30	3.60	6.70	33.1
		7.82	2.40	5.44	29.9
		7.27	2.05	5.22	29.4
		8.46	2.70	5.76	30.5
		7.10	2.10	5.00	29.0
Robert A. Rice,	Pittsfield,	11.26	3.50	7.76	35.2
James Russo,	Maynard,	10.10	3.25	6.85	35.9[1]

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[1] Sour serum.

Milk containing Added Water — Continued.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum at 20° C.
Thomas H. Shaw,	Holliston,	9.84	2.60	7.24	34.0
		10.06	2.60	7.46	34.5
		10.86	3.00	7.86	35.4
		10.20	2.70	7.50	35.0
Charles Simonian,	Methuen,	11.77	3.80	7.97	35.3
		10.41	3.40	7.01	33.6
		11.04	3.75	7.29	34.1
		10.70	3.40	7.30	34.0
		10.60	3.50	7.10	34.7
		11.06	3.60	7.46	34.5
		11.03	3.70	7.33	34.5
		10.94	3.70	7.24	34.1
Joseph B. Smith,	Whitman,	11.50	3.75	7.75	35.2
Joseph Steele,	Provincetown,	11.84	3.90	7.94	35.8
		12.62	4.80	7.82	35.6
Samuel and Nathan Stone,	Ashburnham,	11.58	3.60	7.98	35.6
		11.00	3.40	7.60	35.0
		11.56	3.60	7.96	35.5
		11.48	3.70	7.78	35.3
		10.66	3.40	7.26	34.3
		11.54	3.60	7.94	35.6
		11.14	3.30	7.84	35.2
		11.60	4.30	7.30	34.2
		11.00	3.80	7.20	34.2
		11.70	3.60	8.10	35.7
		11.70	4.00	7.76	35.0
		11.54	3.80	7.74	35.0
		11.30	3.70	7.60	34.8
		11.64	4.20	7.44	34.7
		11.90	4.00	7.90	35.9
		11.54	3.30	8.24	36.0
		11.46	3.80	7.66	35.5
		11.56	3.60	7.96	36.0
		11.60	3.60	8.00	35.8

Milk containing Added Water — Concluded.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum at 20° C.
Samuel and Nathan Stone — *Con.*,	Ashburnham,	11.40	5.00	6.40	35.6
		11.54	3.60	7.94	35.9
		12.46	3.80	8.66	34.9
Comfort Sykes,	Lanesborough,	10.68	3.15	7.53	34.5
		9.16	1.70	7.46	34.3
		11.78	3.85	7.93	35.7
		12.16	4.60	7.56	35.2
Andrew Szala,	Dartmouth,	10.13	3.00	7.13	34.3
Geo. E. Waldron,	Gloucester,	9.44	2.70	6.74	33.6
A. S. Warren,	Fitchburg,	10.60	3.20	7.40	35.5
		10.64	3.40	7.24	35.2
G. Edward Winn,	Burlington,	10.24	3.00	7.24	34.7
		10.90	3.00	7.90	35.7
		10.26	3.20	7.06	33.9
		10.12	3.10	7.02	34.1
		10.12	3.40	6.72	33.3
		11.02	3.20	7.82	35.2
		11.04	3.50	7.54	35.2
Earl H. Wood,	Pittsfield,	10.65	3.30	7.35	34.8
James S. Wotton,	Chelmsford,	10.26	3.00	7.26	33.3
		10.36	3.00	7.36	33.4
		10.90	3.00	7.90	34.1
		10.60	3.20	7.40	33.7
		11.12	3.40	7.72	34.2
		11.10	3.40	7.70	35.6
		11.10	3.40	7.70	35.8
		11.10	3.30	7.80	35.7
		11.42	3.50	7.92	35.8
		11.40	3.40	8.00	35.8
		10.60	3.30	7.30	34.3
		11.00	3.40	7.60	35.3
		5.70	1.10	4.60	28.1
Charles T. B. Young,	Fall River,	9.11	2.65	6.46	33.8
William H. Younger,	Gloucester,	10.02	2.70	7.32	34.2
Frank Zollner,	Pittsfield,	10.72	2.80	7.92	35.9

Milk from which a Portion of the Fat had been removed.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Proteins (Per Cent.).	Solids not Fat (Per Cent.).
H. P. Andreiski,	Lawrence,	10.42	1.60	3.28	8.82
George P. Apostola,	Nantasket,	11.06	2.40	3.06	8.66
John M. Atwood,	Mansfield,	10.64	2.50	3.20	8.14
John Baber,	Hudson,	11.58	2.60	3.18	8.98
Charles H. Backus,	Wollaston,	11.42	2.30	3.35	9.12
Walter F. Beal,	Mendon,	10.55	2.25	2.84	8.30
Matthew J. Bennett,	Woburn,	11.69	2.90	3.48	8.79
		11.80	3.05	3.38	8.75
Charles Bingel,	Newton,	11.18	2.00	3.17	9.18
Daniel Boreyotis,	Lynn,	10.45	1.50	3.30	8.95
J. H. Campbell,	Atlantic,	10.86	2.00	3.17	8.86
Louis W. Cornelius,	Richmond,	11.96	3.10	3.32	8.86
John H. Costello,	Fitchburg,	11.78	2.60	3.46	9.18
Neapolitan Crotian,	Brockton,	11.40	2.60	3.35	8.80
		11.36	2.50	3.30	8.86
		11.38	2.50	3.35	8.88
		11.28	2.55	3.34	8.73
M. N. Curtis,	Medford,	11.52	2.75	3.22	8.77
		10.80	2.10	3.27	8.70
K. Dobrowsky,	Lawrence,	11.80	3.00	3.25	8.80
Demetrius Economos,	Worcester,	10.70	2.60	3.00	8.10
Henry W. Eisner,	Shirley,	11.88	2.80	3.12	9.08
J. W. Elwell,	Winthrop,	10.58	2.20	2.89	8.38
Este Creamery,	Marlborough,	12.10	2.65	3.64	9.45
		10.40	1.20	3.53	9.20
		10.40	1.20	3.53	9.20
William B. Fiske,	Milford,	10.30	2.00	2.92	8.30
		11.20	2.40	3.24	8.80
Winthrop D. Flagg,	North Attleborough,	12.30	2.90	3.24	9.40
John C. Fox,	Dracut,	9.80	0.20	-	9.60
A. H. Gates,	Palmer,	11.20	2.60	2.90	8.60
Henry Hess,	Westfield,	12.10	3.00	3.21	9.10
		12.16	3.00	3.46	9.16
H. P. Hood & Sons,	Boston,	10.78	1.55	3.38	9.23
Harrison G. Kennard,	Wollaston,	11.75	2.50	3.28	9.25

Milk from which a Portion of the Fat had been removed — Concluded.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Proteins (Per Cent.).	Solids not Fat (Per Cent.).
Henry H. Kirchner,	Dalton,	11.32	2.70	3.16	8.62
		11.46	2.40	3.41	9.06
		11.34	2.30	3.48	9.04
		11.60	2.80	3.41	8.80
Henry J. Lavolle,	Millbury,	10.46	1.20	3.69	9.26
Joseph Northrop,	Mendon,	10.62	2.60	2.90	8.02
		11.32	2.60	3.24	8.72
Walter G. O'Connor,	Millbury,	11.40	2.00	3.66	9.40
Ella Olsen,	Revere,	11.40	2.60	3.24	8.80
Samuel L. Perrott,	Waltham,	10.00	1.30	3.28	8.70
Jesse Peters,	Fall River,	11.72	2.90	3.47	8.82
L. Pitinoff,	Quincy,	11.44	2.30	3.35	9.14
Polish and Lithuanian Grocery and Provision Company.	Newton,	11.50	2.60	3.16	8.90
Peter A. Richard,	Spencer,	11.36	2.30	3.30	9.06
James Russo,	Maynard,	10.28	2.15	3.36	8.13
John Rynn,	Wayland,	11.47	2.80	3.31	8.67
Dominic Sarcione,	Lawrence,	11.10	1.80	3.42	9.30
		12.40	3.10	3.34	9.30
Gustav Schmidgall,	Lynn,	11.70	2.40	3.44	9.30
William E. Shockley,	Kingston,	12.02	2.80	3.40	9.22
Horace S. Stockwell,	Millbury,	11.10	2.60	3.00	8.50
Frank Sturgis,	Lanesborough,	11.84	2.80	3.33	9.04
Gerald A. Sullivan,	Atlantic,	10.74	2.00	3.29	8.74
George W. Sykes,	Pittsfield,	10.76	2.55	3.12	8.21
William H. Wakefield,	Spencer,	9.20	0.50	-	8.70
Charles M. Whiting,	Franklin,	9.50	0.60	-	8.90
		9.32	0.60	-	8.72
Charles E. Woodward,	Natick,	10.04	0.40	-	9.64

Quality of Milk by Months.

SAMPLES.	1910.	1911.											
	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	Totals.
Number having more than 15 per cent. total solids.	10	2	7	5	8	4	3	2	5	6	8	8	68
Number having between 14 and 15 per cent. total solids.	51	10	24	22	25	12	12	12	19	22	18	42	269
Number having between 13 and 14 per cent. total solids.	212	84	92	93	132	90	90	45	80	90	110	215	1,333
Number having between 12.15 and 13 per cent. total solids.	180	132	99	132	201	253	258	184	209	107	136	202	2,093
Number having between 11 and 12.15 per cent. total solids.	40	40	18	47	77	68	106	120	127	43	30	30	746
Number having between 10 and 11 per cent. total solids.	6	17	12	19	8	2	11	15	4	9	7	4	114
Number having between 9 and 10 per cent. total solids.	6	1	5	1	12	4	8	4	1	3	4	2	51
Number having between 8 and 9 per cent. total solids.	–	–	–	3	1	1	1	–	–	1	–	–	7
Number having less than 8 per cent. total solids.	–	1	–	6	1	–	–	1	–	–	–	–	9
Number of samples of skimmed milk above standard.	3	–	1	1	1	2	–	–	1	–	4	1	14
Number of samples of skimmed milk below standard.	1	–	–	1	2	1	3	–	1	4	1	–	14
Number of samples of watered milk, .	13	35	12	32	40	5	19	22	14	8	4	9	213
Number of samples above standard, .	456	228	223	253	367	361	363	243	314	225	276	468	3,777
Number of samples below standard, .	49	59	34	75	98	73	126	140	131	56	37	35	913
Total samples collected, ...	505	287	257	328	465	434	489	383	445	281	313	503	4,690

Comparison of Milk Statistics during Five Years.

YEAR.	ENTIRE COLLECTION.			COLLECTION FROM CITIES AND TOWNS.			AVERAGE OF SAMPLES NOT DECLARED ADULTERATED (PER CENT.).		
	Total Samples.	Above Standard.	Per Cent. above Standard.	Total Samples.	Above Standard.	Per Cent. above Standard.	Solids.	Fat.	Solids not Fat.
1907, . . .	2,992	2,000	66.9	2,602	1,766	67.8	-	-	-
1908, . . .	3,934	2,764	70.4	3,418	2,531	74.1	-	-	-
1909, . . .	4,611	3,584	77.7	3,926	3,174	80.7	12.78	4.01	8.77
1910, . . .	5,396	4,353	80.7	4,817	4,001	83.0	12.85	4.02	8.83
1911, . . .	4,690	3,777	80.6	4,459	3,654	82.1	12.83	4.00	8.83

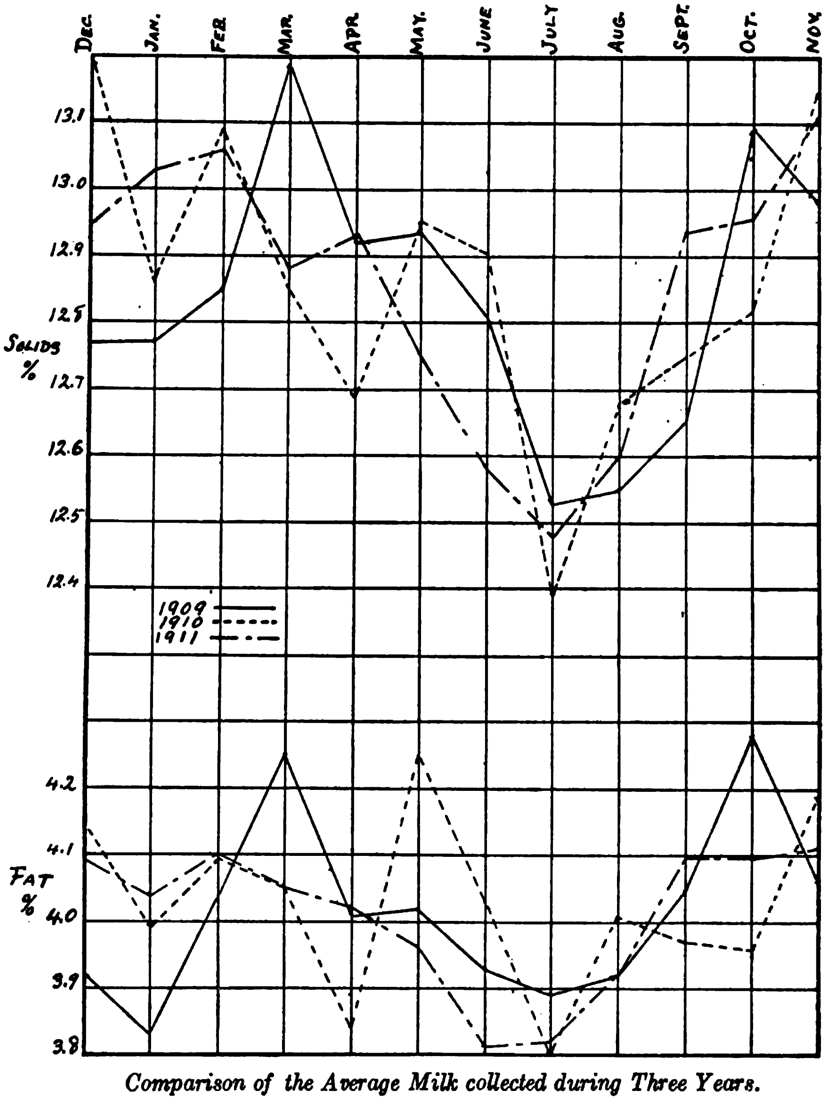
Quality of Average Milk collected.

DATE.	Total Number of Samples.	Average Solids (Per Cent.).	Average Fat (Per Cent.).	Average Solids not Fat (Per Cent.).	Number of Samples not declared Skimmed or Watered.	Average Solids (Per Cent.).	Average Fat (Per Cent.).	Average Solids not Fat (Per Cent.).
1910.								
December,	510	12.81	4.03	8.78	483	12.94	4.09	8.85
1911.								
January,	294	12.60	3.88	8.72	245	13.03	4.04	8.99
February,	278	12.96	4.01	8.95	263	13.06	4.10	8.96
March,	259	12.52	3.92	8.60	227	12.88	4.05	8.83
April,	466	12.64	3.93	8.71	414	12.93	4.02	8.91
May,	491	12.65	3.89	8.76	471	12.75	3.96	8.79
June,	489	12.45	3.73	8.72	454	12.58	3.81	8.77
July,	383	12.34	3.76	8.58	356	12.48	3.82	8.66
August,	443	12.53	3.89	8.64	426	12.60	3.92	8.68
September,	281	12.78	3.96	8.82	258	12.94	4.10	8.84
October,	350	12.87	4.01	8.86	336	12.96	4.10	8.86
November,	421	13.04	4.09	8.95	411	13.11	4.11	9.00

During the year the determination of total solids and fat was made upon all samples collected. These determinations are compiled in the preceding table.

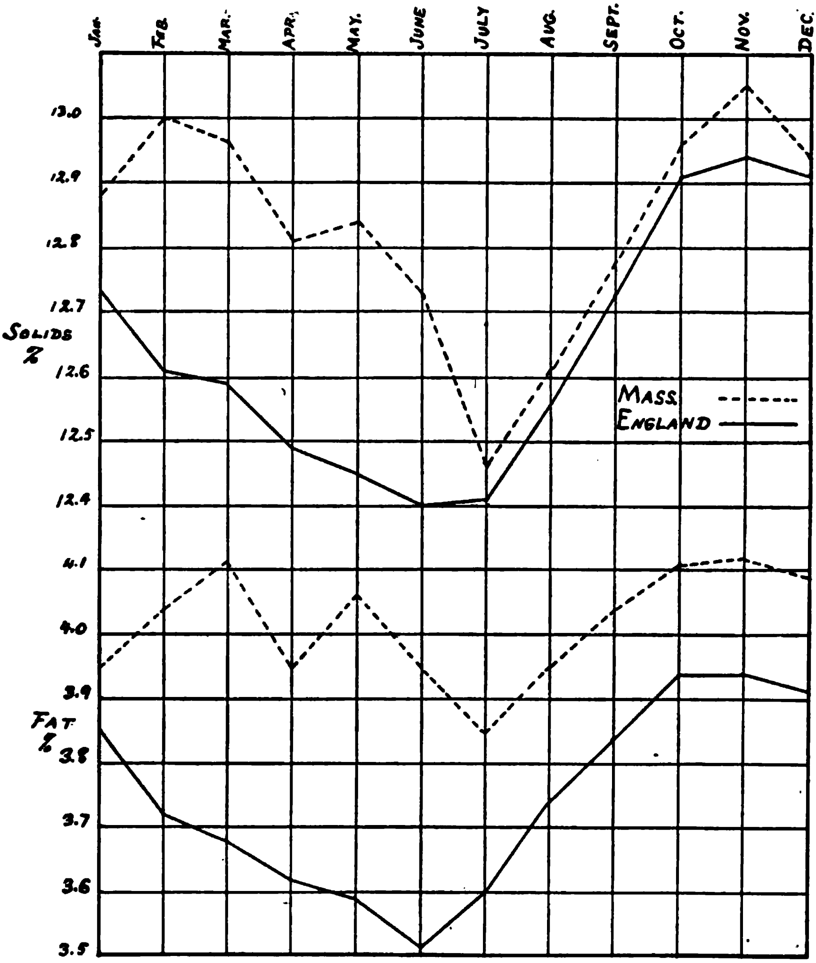
Of the total samples collected, 80.6 per cent. were above the legal standard, the average solids of those not declared adulterated was 12.83 per cent., the average fat 4 per cent. This is slightly less than last year, and about the same as was found in previous years, the figures for 1910 being 80.7 per cent. of the samples above the standard, the average solids 12.78 per cent. and the average fat 4.1 per cent. Four and five-tenths per cent. of the samples were watered. This is slightly higher than in previous years, 1910 showing 3.6 per cent., 1909, 4 per cent., and 1908, 3.4 per cent. The table of the average quality of milk collected shows about the same variations as were found in previous years. The figures of the average composition of the milk not declared adulterated during the past three years have been plotted and are shown in the accompanying chart. It will be seen that the seasonable variation in milk is fairly constant, being the best on the average in November, December, and January, and the worst in July.

In the next chart are plotted the average figures of the solids and fat obtained during the past three years together with the average solids and fat figures reported by H. Droop Richmond of England in the "Analyst" during the three years 1908, 1909 and 1910. Richmond's figures represent the average of 55,234 samples of milk obtained from the farms, and would naturally give a more even curve and show the seasonable variation better than our samples, which represent only 12,848 samples which could not be declared adulterated.



Comparison of the Average Milk collected during Three Years.

It will be noticed, however, that the milk sold in Massachusetts is better than that obtained in England, particularly so in the fat content. This peculiarity of our milk was called to my attention about a year ago by an Englishman who wrote me concerning the known purity samples, published in the report for 1909. He said, "Your figures for fat continue to be higher than we find in this country, notwithstanding that your best cattle are derived from our country. Is it that you can beat us with our own material?" Our figures show slightly lower solids



Comparison of Average Milk sold in Massachusetts with Average Milk sold in England.

not fat, than the English figures, the yearly average being 8.90 per cent. for Richmond's figures and 8.82 per cent. for our figures.

For the determination of added water in milk the copper method of preparing the milk serum has been used with good success during the year. In addition to this we have prepared sour-milk serum on all suspicious samples and determined the index of refraction and ash to supplement the work on the copper serum. The determination of the ash of the sour-milk serum gives another figure for the detection of added water, which is valuable because it is entirely independent of the milk sugar which has the most influence upon the refraction of the milk serum. It has been found possible to declare a sample of milk watered in a number of cases, where the serum has refracted above the lowest limit for pure milk, by making a protein determination. It so happens that in all samples of natural milk having a low refraction of the milk serum, the same samples have had a relatively high protein content compared with the fat. If, upon the determination of the protein, we find the protein fat ratio to be 0.8 or less, we know the sample came either from mixed milk or from a cow giving a high-grade milk. Under these circumstances a minimum refraction of 36.5 or 37 may be taken, and if the refractions of the serum are below this, the samples may be declared watered. In all cases of this nature each sample must be judged upon its own merits, and it is advisable to have a fairly complete analysis of the milk, then, by calculating the milk over to what it was before being watered and seeing if all the constants thus obtained are concordant to pure milk, the samples may be declared watered.

The protein fat ratio has been used during the year to detect skimming in milk. We have made a number of analyses of known purity, milk from Holstein cows, and in all cases the fat has exceeded the proteins. Nine samples above the standard for solids were declared adulterated, of which one was skimmed and the rest watered. The following table gives the analyses of the samples of adulterated milk above the standard: —

Analyses of Adulterated Milk Samples above the Legal Standard.

	Specific Gravity, 15°.	Total Solids (Per Cent.).	Fat (Per Cent.).	Proteins (Per Cent.).	Ratio of Proteins to Fat.	Copper Serum Refraction, 20°.	SOUR SERUM.		Solids not Fat (Per Cent.).
							Refraction, 20°.	Ash (Per Cent.).	
Watered, . .	1.027	13.00	4.90	-	-	35.3	37.1	0.676	8.10
Watered, . .	1.026	12.72	4.80	-	-	35.8	38.4	0.720	7.94
Watered, . .	-	12.62	4.80	-	-	35.6	37.7	0.696	7.82
Skimmed, . .	-	12.40	3.10	3.34	1.08	-	-	-	9.30
Watered, . .	-	12.36	4.15	3.03	0.73	35.7	38.3	0.708	8.22
Skimmed, . .	-	12.30	2.90	3.24	1.12	-	-	-	9.40
Skimmed, . .	-	12.30	2.55	3.55	1.39	-	-	-	9.75
Watered, . .	1.029	12.24	4.30	-	-	35.4	37.1	0.700	7.94
Skimmed, . .	-	12.16	3.00	3.46	1.15	-	-	-	9.16

During the months of July and August each day's collection of milk was mixed together and a complete analysis made of the resulting mixture. Only such samples were left out of this mixture as were sour or could be declared adulterated. Without doubt a large number of adulterated samples were included among the good milk because, on account of the unprecedented hot weather during the month of July together with the enormous demand for milk, a great amount of adulteration was probably practiced. These analyses are reported in the following table: —

Analyses of Mixtures of Milk brought in by the Inspectors during July and August.

Date.	Number of Samples in Mixture.	Total Solids (Per Cent.).	Fat (Per Cent.).	Proteins (Per Cent.).	Ratio of Fat to Proteins.	Ash (Per Cent.).	Solids not Fat (Per Cent.).	Lactose (Per Cent.).	Refraction of Copper Serum, 20° C.	Sour Serum.	
										Refraction, 20° C.	Ash (Per Cent.).
July 1, . . .	15	12.55	3.70	3.22	0.86	0.70	8.85	4.75	36.8	41.0	0.790
July 3, . . .	16	12.30	3.80	3.28	0.86	0.74	8.50	4.50	37.9	40.5	0.770
July 13, . . .	7	12.30	3.60	3.20	0.89	0.75	8.70	4.70	37.1	40.9	0.768
July 17, . . .	32	12.66	3.90	3.26	0.84	0.68	8.76	4.70	37.1	40.8	0.776
July 18, . . .	12	12.19	3.50	3.15	0.90	0.70	8.69	4.70	37.5	40.4	0.772
July 19, . . .	11	12.24	3 50	3.12	0.89	0.68	8.74	4.80	36.7	40.6	0.764
July 20, . . .	10	13.34	4.30	3.30	0.77	0.70	9.04	4.80	37.8	40.0	0.800
July 21, . . .	17	13.00	4.00	3.37	0.84	0.76	9.00	4.65	36.8	41.4	0.758
July 22, . . .	20	12.25	3.50	3.27	0.93	0.73	8.75	4.65	36.6	39.9	0.768
July 25, . . .	26	12.60	3.80	3.30	0.87	0.70	8.80	4.80	37.5	41 0	0.760
July 26, . . .	7	12.80	3.80	3.52	0.93	0.68	9.00	4.80	37.3	41.0	0.800
July 27, . . .	15	12.26	3.60	3.21	0.89	0.70	8.66	4.75	37.1	40.3	0.760
July 28, . . .	25	12.48	3.70	3.33	0.90	0.70	8.78	4.75	37.3	40.9	0.776
July 31, . . .	20	12.50	3.85	3.21	0.83	0.70	8.65	4.60	38.0	40.1	0 780
August 1, . .	11	13.05	4.60	3.00	0.65	0.70	8.45	4.85	38.1	40.8	0.780
August 2, . .	15	12.26	4.00	3.08	0.77	0.70	8.26	4.65	37.0	40.0	0.740
August 3, . .	15	13.18	4.20	3.40	0.81	0.72	8.98	4.80	37.7	41.5	0.760
August 8, . .	17	11.96	3.50	3.13	0.90	0.71	8.46	4.55	37.2	40.2	0.768
August 10, . .	32	12.64	3.80	3.13	0.82	0.71	8.84	4.25	37.5	40.8	0.788
August 11, . .	36	12.60	3.95	3.26	0.83	0.70	8.65	4.65	37.8	40.9	0 812
August 12, . .	30	12.36	3.90	3.12	0.80	0.68	8.46	4.80	37.9	41.2	0.760
August 14, . .	11	12.53	4.05	3.06	0.76	0.70	8.48	4.60	37.3	39.0	0.770
August 15, . .	52	12.55	3.80	3.26	0.86	0.71	8.75	4.70	37.6	40.0	0.770
August 18, . .	48	12.35	4.10	2.92	0.71	0.69	8.25	4.65	37.3	40.4	0.750
August 22, . .	16	12.90	4.30	3.08	0.72	0.72	8.60	5.00	37.0	41.4	0.720

A study of these figures brings out a few peculiarities most of which are due to the enormous demand for milk during hot weather. The mixed samples of July 18 had a low per cent. of solids (12.19), a low per cent of fat (3.50), and high protein (3.15), lactose (4.70) and refraction of the serum (37.5). This sample had also a high protein fat ratio. Recalculating these figures using a fat protein ratio of 0.8 we obtain solids 12.50 per cent., fat 3.95 per cent., proteins 3.15 per cent., ash 0.70 per cent., solids not fat 8.55 per cent. and lactose 4.70 per cent., which are all consistent with pure milk. A similar condition exists in the samples of July 19 and August 8. The samples obtained on these dates probably contained a small amount of skimmed milk.

A sample of milk was obtained from Elias Pelto, Quincy, on October 25. This sample of milk was found to contain over 14 per cent. of solids not fat. A complete analysis was made, with the following results (microscopical examination showed streptococci and pus): —

	Per Cent.		Per Cent.
Fat,	3.50	Ash,	0.90
Casein,	3.78	Lactose,	3.78
Albumin,	5.82	Solids,	17.90

As a result of this analysis Dr. Rose visited the farm and reported one cow with a diseased udder, the milk of which was being mixed with the milk of the other cows and sold in Quincy.

FOOD EXCLUSIVE OF MILK.

There were 1,479 samples of food exclusive of milk collected, of which 351 were found to be adulterated. Under the several headings only such food as require special attention will be discussed.

Butter.

Thirty samples were examined of which 3 were reported adulterated. The adulterated samples consisted of 2 samples of oleomargarine and 1 of renovated butter. Eight samples of oleomargarine and 1 of renovated butter were correctly marked.

Cider.

Eleven of a total of 25 samples were adulterated, 10 containing benzoic acid and 1 containing salicylic acid. Two samples contained benzoic acid and were correctly marked. Only 1 sample was in a bottle bearing a name, as follows: "Pure Russet Cider, J. Kern, Central Falls, R. I.," and was found to contain salicylic acid.

Cocoa.

Two samples were reported adulterated. These were sweetened cocoa. The "A. & P." brand contained 64.08 per cent. of sugar, the Calamata brand contained 64.08 per cent. of sugar.

Coffee Extract.

The 2 adulterated samples were the product of the Goodwin Company, Cambridge, Mass., and were labeled "First Quality Coffee Extract." This extract was found to contain benzoic acid, and furthermore was very deficient in coffee. The following analyses show the composition of 3 samples of coffee extract, one made in the laboratory, one the commercial extract of undoubted purity, and the third, the extract of Goodwin Company.

	Specific Gravity, 15°.	Solids (Per Cent.).	Ash (Per Cent.).	Reducing Sugars (Per Cent.).	Nitrogen (Per Cent.).	Caffein (Per Cent.).	Sodium Benzoate (Per Cent.).
Made in laboratory, . .	1.059	13.56	2.50	0.22	0.36	0.67	-
Commercial, ...	1.057	13.40	2.29	0.17	0.42	0.70	-
Goodwin Company, . .	1.070	21.42	0.93	0.58	0.15	0.14	0.19

Condensed Milk.

Twenty-eight samples were examined of which 4 were reported as adulterated, as they contained skimmed milk. It should, however, be stated that other samples of the same brand were subsequently obtained which could not be called skimmed. The protein fat ratio was used in detecting skimmed milk in condensed milk. The average protein fat ratio of milk is 1:0.8. The amount of skimmed milk in the 4 samples of condensed milk was from 24 to 29 per cent. In all the other samples of condensed milk the fat exceeded the protein. Of 20 samples the highest fat was 9.53 per cent., corresponding protein 7.09 per cent., giving a ratio of 0.83 per cent. The lowest sample had a fat of 6.6 per cent., the protein of 6.18 per cent., giving a ratio of 0.94 per cent. The average of these samples gave a fat of 7.93 per cent. and protein of 7.23 per cent., with a ratio of 0.91 per cent. This ratio is higher than we should expect in mixed milk such as is no doubt used in making condensed milk. Assuming a fat protein of 0.8 per cent., the average sample of condensed milk should have a fat of 9.04 per cent. instead of 7.93 per cent. The table gives the analyses of the 4 skimmed samples: —

List of Adulterated Condensed Milk.

BRAND.	Manufacturer.	Fat (Per Cent.).	Protein (Per Cent.).	Fat corresponding to Proteids (Protein × 1.25) (Per Cent.).
Pearl,	Michigan Condensed Milk Company, N. Y.,	7.05	7.64	9.56
Van Camp,	Van Camp Packing Company, Indianapolis, Ind.	6.75	7.62	9.53
Clover Hill,	The Fox River Butter Company, Aurora, Ill.,	7.50	7.72	9.66
Gold Cross,	Mowhawk Condensed Milk Company, Rochester, N. Y.	5.70	6.39	7.99

Confectionery.

Of the 10 samples reported as adulterated, 8 were coated with talc and two were high-grade chocolates containing human hairs, which latter were sold for 75 cents per pound.

Cream.

One hundred and sixty-six samples were examined, of which 7 were reported adulterated. One sample was low in fat, 1 was watered, and 5 contained formaldehyde, the latter being obtained from Walter G. Kent and John D. Powell, Woonsocket, R. I. No samples were found containing sugar. The absence of added calcium was shown by determining the refraction of the copper serum and the alkalinity of the cream. The alkalinity of 34 samples expressed as cubic centimeters of N/2 acid to neutralize 25 cubic centimeters of cream, using methyl orange as the indicator, was found to vary from 2.3 to 3.8 with an average of 2.8. The refraction of the copper serum of 76 samples of cream was found to vary from 36.2 to 40.8, or an average of 38, and were distributed as follows: 39 to 40.8, 7 samples; 38 to 38.9, 33 samples; 37 to 37.9, 31 samples; 36.2 to 36.9, 5 samples. Samples of cream from one dealer were found to have abnormally high refraction, varying from 41 to 45. These samples also were found to have a high alkalinity varying from 4 to 5. They were found free from added sugar, but were high in calcium. For example, one sample with 37.8 per cent. of fat was found to contain 0.166 per cent. CaO, but pure cream of this per cent. of fat should contain less than 0.14 per cent. CaO. It was first thought a solution of lime and glycerine might have been added, but subsequent investigation found this not to be the case. Determinations were made of the refraction of the copper serum which were found to give high results. Determinations of ash were made which were also found to be high, and the percentage of calcium in the ash was found to be normal. Complete analyses of several samples of the cream have been made, and it was found that all the constituents of the cream except the fat were higher than would be expected in normal cream, and the only conclusion that could be drawn from these results was that condensed milk had been added for the purpose of thickening the cream. The following table shows the results of the analyses of some of these samples, together with the analyses of other commercial samples and of cream separated in the laboratory: —

Analyses of Samples of Pure Cream and Cream suspected of containing Skimmed Milk.

	Fat (Per Cent.).	Protein (Per Cent.).	Lactose (Per Cent.).	Ash (Per Cent.).	Alkalinity of Ash c.c. $\frac{10}{N}$ Acid.	CaO (Per Cent.).	Highest permissible CaO in Pure Cream (Per Cent.).	Alkalinity of Cream.	Refraction of Copper Serum.
Suspected samples, .	29.4	-	-	-	19.6	0.195	0.145	4.0	45.0
	33.2	-	-	-	14.4	0.150	0 136	3.7	41.3
	32.8	-	-	-	14.4	0.143	0.137	3.7	41.7
	37.8	3.08	3.96	0.66	18.8	0.166	0.124	-	42.9
	37.4	3.05	3.94	0.66	14.0	0.152	0.126	-	-
Pure commercial samples,	43.0	2.05	2.48	0.41	8.8	0.099	0.113	-	37.0
	38.8	2.20	2.80	0.48	12.0	0.106	0.122	-	37.5
Separated in laboratory, .	36.2	2.16	2.90	0.45	-	-	-	-	-

Eggs.

One hundred and twenty-two samples were examined during the year, of which 91 were declared adulterated by reason of their being decomposed, which were distributed as follows: —

	Good.	Bad.	Total.
Frozen, ...	6	61	87
Liquid, ...	23	29	52
Powdered, ...	2	-	2

For the chemical examination of eggs determinations were made of ammonia and of acidity. The ammonia was determined by the newer method of Folin as follows: weigh from 6 to 50 grams of egg into a cylinder, add 5 cubic centimeters of a solution containing 10 per cent. sodium carbonate and 15 per cent. potassium oxalate, and a little mineral oil. A current of ammonia free air is blown through the liquid and is then passed through about 50 cubic centimeters of water containing 2 cubic centimeters N/10 acid in a 100 cubic centimeter flask. The time required to obtain all the ammonia depends upon the rapidity of the blast, the size of the cylinder, and the amount of liquid in the cylinder. After the ammonia is all over, 5 cubic centimeters of Nessler solution is diluted to about 40 cubic centimeters and added to the ammonia solution in three portions with constant shaking, and the solution diluted to the mark. The color of this solution is then compared with a standard ammonia solution using a Dubosque colorimeter.[1] After making the colorimetric measurements, the presence of trimethylamine may be recognized in the distillate by the odor of the solution.

The ammonia in the eggs pronounced adulterated extended from 6.7 to 18.4 milligrams per one hundred grams of egg. Trimethylamine was found in 50 samples and 15 samples were found to be musty. Four samples of eggs of known purity were examined for ammonia and the ammonia content ran from 0.48 to 1.06 milligrams per one hundred grams. Storage eggs which were eatable were found to run from 0.7 to 3.95 milligrams of ammonia per one hundred grams of egg. Two prosecutions were made during the year for the sale of these eggs, one against the American Egg Company, the other against Max Schwer in the Superior Court of Suffolk County. In the case against Max Schwer a fine of $25 was imposed and paid. The case of the American Egg Company was placed on file and the eggs were confiscated.

Flavoring Extracts.

One hundred and forty-six samples were examined of which 29 were reported adulterated; these included 16 samples of lemon, 1 of lime, 3 of peppermint, 1 of orange and 6 of vanilla extracts. In the majority of these cases there was a deficiency in the essential oil, and in the case of vanilla extract the addition of coumarin. One lot of extracts, however, deserve special attention, — those obtained from Harry A. Bliss of Salem. These extracts were sold to a Greek in Peabody for the purpose of making soda-water syrups, who in some way became suspicious of the samples and brought some into the laboratory, stating that he heard Mr. Bliss had been using wood alcohol. Inasmuch as the sample of vanilla extract had a marked odor of acetone, the samples were examined and one of the inspectors went to the Greek's place of business in Peabody and also to Mr. Bliss's place in Salem and secured more samples. The samples of vanilla extracts were found to be made with denatured alcohol containing methyl alcohol, the amount of methyl alcohol being from 3.2 to 5.2 per cent. of the total alcohol. Samples of lemon, lime and orange extracts were also found to contain methyl alcohol, and were presumably made with denatured alcohol. In these latter cases, however, the amount of wood alcohol was much less than in the case of vanilla extract, varying from 1.3 to 3.8 per cent. Mr. Bliss was convicted in the Peabody court, fined $200 and appealed. The district attorney thought this case to be of sufficient importance to be placed on file. The following table shows the results of the examination of flavoring extracts: —

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[1] Personal communication from Dr. Otto Folin.

List of Adulterated Flavoring Extracts.

Character of Extracts.	Dealer.	Citral (Per Cent.).	Essential Oil (Per Cent.).	Vanillin (Per Cent.).	Coumarin (Per Cent.).	Methyl Alcohol in Total Alcohol (Per Cent.).
Lemon,	Hall Extract Company, Portland, Me.,	-	0.60[1]	-	-	-
Lemon,	Bliss & Co., Salem,	-	0.00[1]	-	-	1.40
		-	0.00[1]	-	-	1.60
		-	0.00[1]	-	-	2.60
		0.40	0.00[1]	-	-	2.40
Lemon,	Simpson Bros.,	-	0.00[1]	-	-	-
Lemon,	Coleman Specialty Company, Boston,	-	0.09[1]	-	-	-
Lemon,	Simpson Bros., Hyde Park,	-	1.03[1]	-	-	-
Lemon,	Highland Drug and Chemical Corporation, Boston.	-	0.09[1]	-	-	-
Lemon,	A. J. Whitaker, Medford,	-	0.06[1]	-	-	-
Lemon,	Chase & Sons Manufacturing Chemists, Lynn,	-	2.50[1]	-	-	-
Lemon,	"Artificial Flavoring;" Bell Preserving Company, Boston.	0.05	0.00[1]	-	-	-
Lemon,	"Artificial Flavoring," J. H. Folkins Company, Boston.	0.04	0.00[1]	-	-	-
Lime,	Bliss & Co., Salem,	-	0.00[2]	-	-	3.83
Orange,		-	0.00[4]	-	-	1.30
Orange,		-	0.00[3]	-	-	3.20
Orange,		-	0.00[3]	-	-	2.60
Peppermint,	Variety Extract Company, Lynn,	-	1.50[4]	-	-	-
Peppermint,	Henry Siegel Company, Boston,	-	2.30[4]	-	-	-
Vanilla,	Providence Extract Company, Providence, R. I.	-	-	-	0.132	-
Vanilla,	Bliss & Co., Salem,	-	-	-	present	5.20
		-	-	-	present	3.50
		-	-	-	present	4.40
Vanilla,	Simpson Bros. Company,	-	-	0.44	0.640	-
Vanilla,	No name or brand,	-	-	-	0.098	-
		-	-	0.54	0.260	-

[1] Lemon oil. [2] Lime oil. [3] Orange oil. [4] Peppermint oil.

Jams and Jellies.

Forty samples were examined of which 5 were declared adulterated. These 5 contained from 10 to 20 per cent. of glucose and were labeled "Containing Sufficient Corn Syrup to prevent Crystallization." This amount of glucose being much in excess of what would be necessary to prevent crystallization, the samples were declared adulterated.

Lard.

Thirty-six samples were examined 7 of which were called adulterated, being the usual mixtures of cottonseed oil with lard stearine, beef stearine or both.

Maple Products.

Sixty-seven samples were examined and 9 samples each of maple sugar and maple syrup were declared adulterated. The percentage of cane sugar varied from 20 to 90 in the syrups and from 50 to 90 in the sugars.

Meat Products.

Two hundred and thirty-three samples of meat products were examined and 96 were adulterated as follows: 2 samples canned sausages contained cereal, the percentage not being stated on the label, 2 samples of hamburg steak were adulterated with sodium sulphite containing, respectively, 0.1 and 0.24 per cent., 90 samples of sausages were adulterated, 45 containing wheat starch, 41 containing corn starch, 3 containing both and 1 containing potato starch. One sample of sausage was marked to contain sodium benzoate and was found free from benzoates and other preservatives. The two samples of tripe contained a boron preservative.

Olive Oil.

Eighty-one samples were examined, 15 of which were adulterated with cottonseed oil and 1 of which contained both lard and cottonseed oil. The percentage of cottonseed oil in the samples varied from 60 to 100 per cent. The brands of the adulterated olive oil are given in the following table: —

List of Adulterated Brands of Olive Oil.

Brand.	Cottonseed Oil (Per Cent.).
Olio Soprafino Fracescani Brand Olive Oil and Salad Oil,	90
Berti Brand, compound of olive oil with cotton salad oil,	90
Superior Quality Oil, compound of olive oil and cottonseed oil,	85
Compound of olive oil and cotton salad oil, Tropani Brand,	85
Olio D'oliva Sopraffino di Sorrento, Masenello Pure Olive Oil, Donato Maddaloni,	60

Pickles.

Fifty-seven samples were examined, 5 of which were adulterated; 2 of these contained benzoic acid, 2 contained alum without being labeled, and 1 sample contained alum, the presence of which, but not the amount, was stated upon the label.

Proprietary Foods.

A single adulterated sample was "Milk Cordial-Panna Cream, a Health Tonic prepared by Prof. Antonia Alai, Suterville, Pa., aids digestion, a stimulating auxiliary food, rich in all nutritive principles." Analysis is as follows: —

	Per Cent. by Volume.		Per Cent. by Volume.
Alcohol,	0.16	Invert sugar,	0.59
Solids,	25.04	Nitrogen,	0.00
Ash,	0.04	Fat,	0.00
Sucrose,	24.00		

It will be seen from this analysis that this food was not rich in all nutritive principles, containing neither nitrogen nor fat, and the principal stimulating quality was the alcohol.

Rice.

Six samples of rice were examined and found to contain talc, the amount of talc varying from 0.06 to 0.17 per cent.

Table Sauces.

Thirty-five samples were examined, 11 of which were adulterated. These adulterated samples were all tomato ketchup containing benzoic acid. The amount or presence of this were stated either incorrectly or not at all. The following is the list of the adulterated brands of tomato ketchup with the amount of benzoic acid found: —

List of Adulterated Samples of Tomato Ketchup.

BRAND.	Manufacturer or Wholesaler.	SODIUM BENZOATE.	
		Marked (Per Cent.).	Found (Per Cent.).
Merrimac Tomato Catsup,	F. M. Bill, Lowell,	0.100	0.170
Bay State Brand Tomato Catsup,	H. M. Dillon & Co., Stoneham,	0.100	0.202
Oakland Brand Tomato Catsup,	Delight Pickle and Preserving Company,	–	0.063
Belvidere Brand Tomato Catsup,	Delight Pickle Company,	0.002	0.144
Delight Brand Tomato Catsup,	Delight Pickle and Preserving Company, Lowell,	0.002	0.104
Merrimac Valley Tomato Catsup,	Fiedler Bros. Company, Lawrence,	–	Yes.
Crescent Brand Tomato Catsup,	Charles L. Hirsh & Co., N. Y.,	–	0.150
Perfection Tomato Catsup,	Standard Grocery Company,	0.100	0.216
Standard Brand Tomato Catsup,	Standard Importing Company, Boston,	0.100	0.210

The other samples of table sauce which were found good consisted of piccalilli, proprietary sauces, Worcestershire sauce and grape ketchup.

Vinegar.

Sixty-four samples were examined, 41 of which were declared good. The vinegar prepared by the Fleischmann Company, called Fleischmann's syrup vinegar, was declared adulterated by reason of its being a colored distilled vinegar. This vinegar is said to be made as follows: molasses is fermented and a portion distilled. This alcoholic distillate is then mixed with some undistilled fermented molasses, and the mixture put through generators. The finished product corresponds in analysis to the mixture of 15 per cent. molasses vinegar and 85 per cent. distilled vinegar. It was alleged that this mixture was a colored distilled vinegar. The court held that the vinegar was not colored. The samples of adulterated vinegar are as follows: 11 were the Fleischmann so-called molasses vinegar and 12 samples of cider vinegar of which 3 were low in solids, 4 low in acids, and 5 not pure cider vinegar. Cider vinegar is without doubt the most adulterated of any article of food outside of milk, but the adulteration may be said to be insignificant from the health, or from a food value, point of view. People buy vinegar for the acid it contains, and it makes no difference in this respect from what source the acid is derived. The manufacturers of adulterated cider vinegar can make a substance which can pass fairly well for the pure article, and new factors have arisen which makes the chemical examination more expensive. The methods employed by some manufacturers using dried apple waste is about as follows: after the fresh apples have been pressed, the pomace is allowed to stand around for a few days, and after developing a fermentation, pressed a second time. In this second pressing the dried-apple products are soaked, the mixture is again pressed and the resulting liquid made into vinegar. This vinegar will have a very high solid content and a large amount of acetic acid and can be added to cider vinegar which has been watered. After watering to the legal standard of solids, if the acidity is too low, distilled vinegar is added to bring it up to the legal standard.

The following table gives the results of the analyses of 8 samples of vinegar submitted as pure by different manufacturers: 3 were made by the slow process by one manufacturer, 1 made by regenerator by another manufacturer and 4 were made by the generated process by a third manufacturer.

Analyses of Alleged Pure Cider Vinegar.

Alcohol (Per Cent.).	Acid (Per Cent.).	Solids (Per Cent.).	Reducing Sugars (Per Cent.).	Nonsugar Solids (Per Cent.).	Polarisation.	In Solids.			Pentosans (Per Cent.).	Ash (Per Cent.).	Alkalinity of Ash.	P_2O_5 Mg. per 100 c.c.	Per Cent. of Ash in Solids.	Per Cent. of Ash in Nonsugar Solids.
						Sugars (Per Cent.).	Dextrose (Per Cent.).	Levulose (Per Cent.).						
0.00	6.16	1.72	0.34	1.38	—1.13	19.6	5.2	17.5	0.094	0.376	37.4	20.4	21.7	25.4[1]
0.00	5.24	1.86	0.33	1.53	—1.05	17.7	6.1	13.8	0.110	0.347	36.7	32.4	18.6	22.7[1]
0.00	5.42	1.74	0.35	1.39	—1.10	20.1	5.8	15.6	0.099	0.361	38.2	21.6	20.7	25.9[1]
0.11	5.16	2.53	1.25	1.28	—4.22	49.5	13.1	39.8	0.106	0.302	30.6	21.6	11.9	23.6[2]
0.11	5.12	2.69	1.34	1.35	—4.25	49.8	14.3	38.8	0.192	0.318	28.6	24.4	11.8	23.6[2]
0.11	5.03	2.85	1.38	1.47	—4.68	48.5	12.8	39.0	0.198	0.335	35.0	30.8	11.7	22.8[2]
0.26	4.84	2.04	0.66	1.38	—2.25	27.5	4.7	24.3	0.124	0.270	28.6	29.2	13.2	19.6[2]
0.11	4.32	2.02	0.57	1.45	—2.23	28.2	5.6	24.8	0.144	0.357	35.4	23.2	17.7	24.6[2]

[1] Slow process. [2] Generator process.

Yeast.

Two samples of yeast were found to contain starch. Prosecutions resulting were nol-prossed by the district attorney. The dictionary definition of compressed yeast as yeast containing starch was held by the district attorney as being sufficient standard of purity.

Summary of Statistics of Food exclusive of Milk.

	Genuine.	Adulterated.	Total.		Genuine.	Adulterated.	Total.
Baking powder,	4	-	4	**Coffee extract,**	2	2	4
Bread,	2	-	2	**Condensed milk,**	24	4	28
Buckwheat flour,	1	-	1	**Confectionery,**	35	10	45
Butter,	27	3	30	**Corn starch,**	2	-	2
Canned fish,	9	-	9	**Cream,**	159	7	166
Canned fruits and vegetables,	17	-	17	**Cream of tartar,**	19	-	19
Cereal,	1	-	1	**Dried fruit (figs),**	1	-	1
Cheese,	9	-	9	**Eggs,**	31	91	122
Cider,	14	11	25	**Flavoring extracts: —**			
Clams,	1	-	1	**Almond,**	1	-	1
Cocoa,	19	2	21	**Anise,**	1	-	1
Coffee,	4	-	4	**Lemon,**	30	16	46

Summary of Statistics of Food exclusive of Milk — Concluded.

	Genuine.	Adulterated.	Total.		Genuine.	Adulterated.	Total.
Flavoring extracts — *Con.*				**Meat products** — *Con.*			
Lime,	–	1	1	Mince meat,	8	–	8
Nutmeg,	2	–	2	Pressed meat,	7	–	7
Orange,	1	3	4	Sausages,	89	90	179
Peppermint,	10	3	13	Tongue,	1	–	1
Vanilla,	68	6	74	Tongue cheese,	1	–	1
Wintergreen,	4	–	4	Tripe,	10	2	12
Flour,	1	–	1	Molasses,	5	–	5
Fruit juices: —				Nonalcoholic drinks,	5	–	5
Grape,	9	–	9	Nuts,	1	–	1
Lemon,	2	–	2	Olive oil,	63	18	81
Orange,	1	–	1	Oysters,	9	–	9
Raspberry,	1	–	1	Pastry,	3	–	3
Gelatin,	1	–	1	Peanut butter,	4	–	4
Honey,	18	–	18	Peanut oil,	1	–	1
Horseradish,	6	–	6	Pickles,	52	5	57
Hulled corn,	1	–	1	Proprietary foods,	7	1	8
Jams and jellies,	35	5	40	Rice,	2	6	8
Lard,	29	7	36	Salad dressing,	20	–	20
Malt liquor,	16	–	16	Salad oil,	1	–	1
Maple sugar,	29	9	38	Spices,	65	–	65
Maple syrup,	20	9	29	Sugar,	1	–	1
Meat products: —				Syrup,	9	–	9
Beef steak,	2	–	2	Table sauce,	24	11	35
Canned meats,	2	2	4	Vinegar,	41	23	64
Hamburg steak,	12	2	14	Yeast,	9	2	11
Head cheese,	2	–	2	Yeast extracts,	2	–	2
Jellied tongue,	2	–	2	Totals,	1,128	351	1,479
Lambs' tongues,	1	–	1				

DRUGS.

One thousand one hundred and fourteen samples were examined, of which 218 were adulterated. Only such drugs as need special comment will be discussed.

Alcohol.

One hundred and six samples examined, of which 6 were adulterated. These six samples contained from 39 to 76 per cent. alcohol by volume. The other 100 samples were over 94 per cent. alcohol. The adulterated samples were all in unlabeled bottles.

Chlorinated Lime.

The adulterated sample obtained was from Legget Bros., New Jersey, and contained 50 per cent. of the required amount of available chlorine.

Denatured Alcohol.

One hundred and six samples were examined, 61 of which did not bear the poison label required by law.

Elixir of Potassium Bromide.

Seventeen samples were collected 7 of which were deficient in potassium bromide. The following list gives the names of the pharmacists together with the results of the analyses of these 7 samples: —

DEALER.	Potassium Bromide (Per Cent.).	Required Strength (Per Cent.).
Frank S. Colley, Boston,	15.24	87.1
Burroughs Bros., Boston,	15.22	87.1
Geo. F. Sanborn & Son, Roxbury,	14.98	85.6
People's Drug Store, Boston,	14.18	81.0
Green, The Druggist, Springfield,	12.16	69.4
Frank A. Brandle, Northampton,	10.50	60.0
Hall & Lyon Company, Lowell,	5.39	30.8

Camphor Liniments.

There were 6 adulterated samples of a total of 108 collected. The following is the list of the 12 dealers from whom these samples were taken, together with the results of the analyses: —

DEALER.	Camphor (Per Cent.).	U. S. P. Strength (Per Cent.).
Charles A. Baker, Fall River,	7.6	38
Boyagian's Pharmacy, Boston,	5.7	28
Boston Cut Price Drug Store, C. H. Goldthwaite,	10.2	51
A. W. Cunningham, Springfield,	8.8	44
John L. Forrest, Lawrence,	17.0	85
Franklin Pharmacy, Roxbury,	15.5	77
Lafayette Square Pharmacy, Haverhill,	16.8	84
Frederick L. Pratt, Boston,	14.0	70
Frederick L. Pratt, Boston,	13.6	68
Roma Pharmacy, D. W. Risen, Boston,	16.5	83
D. F. Rourke, Brighton,	10.2	51
South End Pharmacy, S. Feldman, Boston,	15.7	78
Variety Extract Company, West Lynn,	3.5	17

Methyl Alcohol.

Twenty-eight samples were found not labeled "poison" in accordance with the law. In many instances methyl alcohol was sold for denatured alcohol.

Proprietary Medicines.

Sixty-seven samples were obtained, of which 16 were reported adulterated. It should be understood, however, that in some cases more than one sample was obtained from the same dealer, the analyses of which were identical. The following list gives the names of the adulterated samples: —

List of Adulterated Proprietary Drugs.

NAME OF DRUG.	Dealer.	Found.
Boscher's German Syrup for Consumptives, etc.	– –	Morphine.
Gauvin's Aniseed Syrup,[1]	R. A. Gauvin, Lowell,	.84 grains morphine acetate per fluid ounce.
Thymo Septol,	McLaughlin & Dennison, Woburn,	22.84 per cent. alcohol.
Vino Sangré, medicinal wine,	S. S. Pierce Company, Boston,	19.68 per cent. alcohol.
Arnold's Bromo Celery,	Arnold Chemical Company, Chicago,	Acetanilid.
Laxative Quinine Tablets,	Standard Soap Works, Boston,	Acetanilid.
Robbin's Headache Powders,	McLaughlin & Dennison, Woburn,	Phenacetine.

[1] Contains ⅛ grain morphine acetate per fluid ounce.

Quinine Pills.

The single sample of quinine pills collected during the year was adulterated and was obtained from the Independent Pharmaceutical Company of Worcester. The samples were examined by means of the polariscope, which showed them to contain 1.25 grains of quinine sulphite per pill. By extraction with chloroform and weighing they were found to contain 1.27 grains per pill. The pills purported to be 2-grain pills.

Spirit of Nitrous Ether.

Adulterated samples were obtained from the following dealers: —

	Ethyl Nitrite (Per Cent.).	Per Cent. of U. S. P. Requirements.
Prichard Pharmacy, Worcester,	2.66	66
Towers Corner Drug Store, Lowell,	1.71	43
Walter M. Hatch, Stoneham,	0.90	23

Spirit of Anise.

The 3 adulterated samples were obtained from B. F. Riddell, Fall River, and 2 from Charles A. Baker of Fall River. These samples contained, respectively, 2.9–, 2.9–, and 2.3 per cent. anise oil, the pharmacopœial requirement being 10 per cent.

Spirit of Camphor.

Three of the adulterated samples were obtained from Lawrence A. Dwyer & Co., Webster, Charles E. Collins and Henry E. Morgan in Milford. These samples contained from 83.3 to 82.7 per cent. of the required amount of camphor. One other sample was adulterated, but was over 90 per cent. of the requirements, which was too good for prosecution.

Spirit of Gaultheria.

All the 15 samples examined were good. The method employed was as follows: place 10 cubic centimeters of the sample in a beaker, add 40 cubic centimeters N/10 sodium hydroxide. Boil until saponified and titrate the excess of alkali with N/10 acid. The amount of alkali used multiplied by 0.152 gives the per cent. of methyl salicylate. The samples examined were found to contain from 4.58 to 6.23 of wintergreen oil.

Spirit of Peppermint.

Three hundred and seventy-seven samples were examined, of which 53 were adulterated. The following table gives the list of dealers from whom adulterated samples were obtained. From a large number of these dealers more than one sample was obtained. In all these cases the analysis of the worst sample secured is given.

List of Dealers selling Adulterated Spirit of Peppermint.

Dealer.	Per Cent. of Required Strength.	Dealer.	Per Cent. of Required Strength.
Geo. H. Adams, Newburyport, . .	17	Davis & Hatch Spice Company, New Bedford.	4
Bradford's Pharmacy, North Adams,.	14	Francis P. Downe, Charlestown, .	66
Brody & Simon, Roxbury, . . .	73	Gammen & Broderick, Haverhill, .	46
W. A. Burnam Company, Lawrence, .	66	J. B. Goudreau, Fall River, . .	10
Charles Clarke & Son, Lawrence, .	61	Gilchrist Drug Company, Boston, .	73
E. Consineau, Fall River, . . .	42	S. A. Epstein, Boston, . . .	71
Walter L. Connel, Boston, . . .	29	Fisher's Pharmacy, Mansfield, . .	72

List of Dealers selling Adulterated Spirit of Peppermint — Concluded.

DEALER.	Per Cent. of Required Strength.	DEALER.	Per Cent. of Required Strength.
Haverhill Drug and Chemical Company, Haverhill.	27	Samuel B. Roos, Roxbury, . .	53
Geo. S. Hull & Co., Lowell, . .	18	Routhier & Delisle, Lowell, . .	44
Lévasseurs Pharmacy, Worcester, .	78	L. J. Sinnotte, Haverhill, . . .	55
Morse, Winslow Drug Shop, Boston, .	40	B. S. Stacy, Charlestown, . . .	65
Charles A. Nelson, Haverhill, . .	36	Stevens & Dow, Haverhill, . .	48
Pharmacie Français, Lowell, . .	19	John S. Tobin, Boston, . . .	23
Ralph B. Quinland, Boston, . .	71	N. C. Tozier & Co., Haverhill, . .	67
John A. Rice, North Adams, . .	20	Varsity Extract Company, Lynn, .	-
B. F. Riddell, Fall River, . . .	13	W. A. Volkman, Worcester, . .	22

Tincture of Arnica.

Thirty-one samples were collected during the year, of which 10 were reported adulterated. For the purpose of determining the purity of tincture of arnica we have relied upon the determination of total solids. The following table gives the percentage of solids and of ash found in 22 good samples: —

	Per Cent.		Per Cent.
Highest solids, . . .	5.19	Highest ash, ...	0.61
Lowest solids, . . .	3.10	Lowest ash, ...	0.44
Average solids, . . .	4.12	Average ash, . . .	0.52

Adulterated samples were obtained from the following dealers: —

DEALER.	Solids (Per Cent.).	Ash (Per Cent.).
Fred. F. Bradbury, Boston, ...	2.06	-
Fred W. Boulton, Spencer, ...	2.24	-
Connelly's Pharmacy, Boston, ...	2.17	-
C. P. Flynn, Boston, ...	2.46	0.36
Harring & Teele, Dorchester, ...	2.52	-
William F. Phelps, Boston, ...	1.75	0.25
J. H. Stewart & Co., Charlestown, ...	2.68	0.40
Henry L. White, Somerville, ...	2.40	0.26

Tincture of Iodine.

The samples of tincture of iodine collected during the year were, on the whole, very good, only 8 samples being adulterated. Two of these 8 samples were obtained from the Savannah Drug Company, Roxbury, and were, respectively, 62.2 and 74 per cent. of the pharmacopœial requirements.

Zinc Ointment.

The single sample examined was obtained from James E. Fitzgerald, Salem, and was found to contain 17.11 per cent. of zinc oxide instead of 20 per cent., as required.

Summary of Statistics of Drugs.

	Genuine.	Adulterated.	Total.
Acacia,	7	-	7
Alcohol,	100	6	106
Aluminii sulphas,	1	-	1
Aqua hamamelidis,	15	-	15
Aqua rosæ fortior,	1	-	1
Calcii phosphas,	1	-	1
Calx chlorinata,	1	1	2
Cera alba,	5	-	5
Cera flava,	1	-	1
Cetaceum,	1	-	1
Denatured alcohol,	45	61	106
Elexir potassii bromidi,	10	7	17
Fluid extractum zingiberis,	1	-	1
Linimentum camphoræ,	92	16	108
Methyl alcohol,	7	28	35
Morphine pills,	1	-	1
Oleum morrhuæ,	1	-	1
Oleum olivæ,	6	-	6
Oleum ricini,	2	-	2
Oleum terebinthinæ,	1	-	1
Proprietary medicines,	51	16	67
Quinine pills,	-	1	1
Sodii boras,	8	-	8
Spiritus ætheris nitrosi,	3	3	6
Spiritus anisi,	9	3	12
Spiritus camphoræ,	50	4	54
Spiritus frumenti,	2	-	2
Spiritus gaultheriæ,	15	-	15
Spiritus menthæ piperitæ,	325	52	377
Spiritus myrciæ,	1	-	1
Strychnine pills,	1	-	1
Sulphur præcipitatum,	1	-	1
Tinctura arnicæ,	21	10	31
Tinctura iodi,	106	8	114
Tinctura nucis vomicæ,	2	1	3
Tinctura opii camphorata,	1	-	1
Tinctura rhei,	1	-	1
Unguentum zinci oxidi,	-	1	1
Totals,	896	218	1,114

INSPECTION OF LIQUOR.

The police department of 28 cities and towns sent in during the year 116 samples of liquor for examination, of which 88 contained more than 1 per cent. and 28 contained less than 1 per cent. of alcohol. The following table gives the number and character of the samples obtained from different localities. The samples of miscellaneous liquor consisted of sink mixtures, rum, brandy, beef, iron and wine, gin, Jamaica ginger and one sample of sand. The sample of sand came from Hudson. The police found in the floor of the raided building a hole with a funnel underneath it. The proprietor was prevented from running any water down the funnel and the officers collected some moist sand from the cellar floor underneath the funnel. This wet sand was found to contain 16.62 per cent. of alcohol by weight. The proprietor of the establishment was convicted in the lower courts, fined and appealed. In the superior court he pleaded nolo and paid $50. The attendance of the assistant analyst has been required in the lower courts of Hudson, Gloucester, Abington, Cambridge, Lynn, Roxbury, Waltham and in the superior court at East Cambridge and Plymouth.

Summary of Liquor Statistics.

LOCALITY.	Whiskey.	Beer.	Cider.	Wine.	Miscellaneous.	Total.
Arlington,	-	-	1	3	3, malt extract,	7
Attleborough,	-	-	-	-	1, unknown,	1
Avon,	-	-	1	-	- -	1
Ayer,	-	-	2	-	- -	2
Boston,	-	4	-	1	3, unknown,	8
Braintree,	-	-	-	5	- -	5
Danvers,	-	-	3	-	- -	3
Fall River,	-	-	-	2	2, beef, iron and wine, 1 unknown,	5
Fitchburg,	-	-	4	-	- -	4
Foxborough,	-	-	2	-	- -	2
Franklin,	-	1	-	-	- -	1
Gloucester,	-	6	-	-	5, unknown,	11
Hanover,	-	1	-	-	- -	1
Hudson,	-	-	-	-	1, sand,	1
Hyde Park,	-	-	1	-	2, Jamaica ginger,	3
Lexington,	-	-	1	-	- -	1
Lynn,	2	-	6	3	4, unknown,	15
Norwood,	-	-	2	1	- -	3
Peabody,	-	-	2	-	1, syrup,	3
Plymouth,	-	-	-	2	1, unknown,	3
Quincy,	-	2	-	-	1, malt extract; 1, Jamaica ginger,	4
Reading,	-	-	1	-	- -	1
Revere,	-	5	-	2	- -	7
Rowley,	-	-	1	-	- -	1
Salisbury,	-	9	-	-	- -	9
Waltham,	-	1	5	-	- -	6
Winchester,	-	-	2	-	- -	2
Worcester,	2	-	-	-	4, distilled liquors,	6
Totals,	4	29	34	19	30,	116

EXAMINATION OF POISONS.

One hundred and fifty-one samples of poison were submitted during the year, of which 72 were submitted by the Boston police, 68 by the Watch and Ward Society, and the other 12 by the police of Gloucester, Peabody, Quincy, Upton and the district police. Most of the analytical work of these substances has been done by Mr. C. H. Hickey. The following table gives the list of poisons submitted: —

List of Alleged Poisons submitted by Police Department and the Watch and Ward Society.

SUBSTANCE.	Boston Police.	Gloucester Police.	Peabody Police.	Quincy Police.	State Police (Lowell).	Upton Police.	WATCH AND WARD SOCIETY.			Total.
							Boston.	Lawrence.	New Bedford.	
Abortive liquid containing ergot, .	1	-	-	-	-	-	-	-	-	1
Chinese fruit, ...	-	1	-	-	-	-	-	-	-	1
Cocaine hydrochloride, . . .	11	-	-	-	-	-	21	-	-	32
Corn husks containing paris green, .	-	-	-	-	-	1	-	-	-	1
Epsom salts, ...	-	-	-	-	2	-	-	-	-	2
Eye opener (Rochelle salts, sodium carbonate, sodium chloride).	1	-	-	-	-	-	-	-	-	1
Heroin hydrochloride, . . .	1	-	-	-	-	-	-	-	-	1
Heroin tablets, ...	-	-	-	-	-	-	1	-	-	1
Methylene blue pills, . . .	-	-	1	-	-	-	-	-	-	1
Morphine pills, ...	2	-	-	-	-	-	16	-	-	18
Morphine sulphate, ...	17	-	-	-	-	-	-	-	-	17
Opium, ...	25	1	-	-	-	-	21	1	5	53
Opium ash, ...	11	-	-	-	-	-	2	-	-	13
Roach salt (sodium fluoride), . .	-	-	-	-	4	-	-	-	-	4
Rochelle salts, ...	-	-	-	-	1	-	-	-	-	1
Suspected cocaine (sodium chloride),	1	-	-	-	-	-	-	-	-	1
Whiskey and codeine, . . .	-	-	-	-	-	-	1	-	-	1
Whiskey and nicotine, . . .	1	-	-	-	-	-	-	-	-	1
Wine containing 4.5 per cent. salt, .	-	-	-	1	-	-	-	-	-	-
Totals, ...	71	2	1	1	7	1	62	1	5	151

Of these samples 8 were declared legal, 143 illegal, or poisons. The single sample of abortive liquid submitted by the Boston police was examined for ergot. The method of Hoffman for ergot in flour[1] was employed as follows: a portion of the sample was made acid and shaken with ether, the ether extract washed with water, and shaken in a cylinder with a few drops of saturated sodium carbonate. The characteristic violet color was produced in the aqueous layer. The methyl alcohol test described in the same book did not give satisfactory results. A portion of the sample was shaken with strong potassium hydroxide, according to the method described in the United States dispensatory, and gave a peculiar odor. On adding a drop of dilute hydrochloric acid on a stirring rod, a heavy white cloud formed and dropped to the bottom of the tube.

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[1] Substances Alimentaries, A. Villiers et E. Collin, p. 90.

All of these tests were tried in conjunction with a known sample of fluid extract of ergot and as both solutions gave the same reactions the sample was declared to contain ergot from these tests. In the trial of the case the police department had other testimony of a circumstantial nature which tended to supplement the chemical examination.

The 32 samples of cocaine hydrochloride submitted were in all cases the pure salt, and it was identified by the usual physiological test supplemented by the precipitates obtained with iodine in potassium iodide, Mayers mercuric iodide solution, and the characteristic crystals obtained with platinum chloride. The sample of corn husks containing paris green was sent in by a constable in the town of Upton. These were found in a corn field which had been burned. The single sample of heroin hydrochloride was found on a prisoner. The heroin tablets were purchased. About one-third of the cocaine samples were found on prisoners and the other two-thirds were purchased or seized. The morphine sulphate in the majority of cases was found upon or delivered to prisoners. The sample of whiskey and codeine was a cough mixture containing also a large amount of cane sugar. This was sold on prescription and was being repeatedly refilled by the druggist and delivered to a small child. A sample of whiskey and nicotine was supposed to be a "knock-out" preparation. It was found free from chloral, cocaine, morphine, etc. Nicotine was detected by distilling from alkaline solution, and identifying it in the distillate by means of the polariscope and the usual color and precipitation reactions.

The sample of wine containing salt was submitted to the Quincy police by a doctor. There was a suspicion that somebody was endeavoring to poison a person by means of this wine. No poisons could be detected in the wine, and we have been unable to find out any further circumstances in regard to the sample.

The 7 samples submitted by the State police came in as a result of the death of a small child and the sickness of two adults in Lowell. The small child of ten was sent to a drug store for some Rochelle salts.

She went home, took the usual dose of the Rochelle salts and subsequently died before a physician could be obtained. The two adults in another family purchased some Rochelle salts in the same drug store and were made sick, but recovered. The State police brought in the sample left of what the little girl took, which was found to contain 88.73 per cent. sodium fluoride. The box came from "James O'Brien, Lowell, the Reliable Druggist." Further investigation by the district police showed that O'Brien obtained the Rochelle salts from the C. B. Coburn Company, an artists' supply house in Lowell. Examination of the premises of the Coburn Company showed that they had a barrel of roach salt and a barrel of Rochelle salts in close proximity. Samples were obtained from each and examined and the roach salt corresponded in analysis to the alleged Rochelle salts sold by O'Brien. The result of the inquests on these cases was that nobody was criminally liable. There have been a number of fatalities of this sort due to the mistaking of roach powder for other substances. Mr. Herbert B. Baldwin reported in the "Journal of the American Chemical Society" (1899, p. 517) a number of cases of sickness and death resulting from mistakes of this sort.

He reported one case of sickness and one death resulting from the eating of pancakes served for breakfast. In this case the box of roach salt which contained the fluoride was found by the side of a baking powder box. Another similar accident occurred. A man, his wife, and daughter were made seriously sick for a number of days by eating wheat cakes prepared with cockroach powder instead of baking powder, the powder containing fluoride. The mother, who was more seriously affected, was confined to her bed for two weeks. Mr. Baldwin also reported two other cases heard of: a man who was made to vomit by merely tasting the substance a few times, and another man who was made sick by taking about 50 grams, while intoxicated, mistaking it for Rochelle salts. He was soon taken with violent vomiting and purging, but recovered in a few days.

Some time after the inquest on the child above referred to we purchased 12 samples of roach powder, 5 of which were found to contain from 15 to 62 per cent. of this most violent poison. Some of these samples were labeled harmless, others slightly poisonous, and another poisonous to insects and not to human beings. It seems as if sodium fluoride should be recognized as a highly toxic substance, and our poison law so amended that all preparations containing any soluble fluoride shall be distinctly labeled "POISON," as is required in the case of rough on rats. The following table gives the results of the analyses of these 5 samples of roach powders containing sodium fluoride: —

Insect Powder containing Sodium Fluoride.

Name of Powder and Manufacturer.	Statement on Label regarding Poisonous Nature or Other Cautions.	Per Cent. of Fluoride calculated as Sodium Fluoride (Per Cent.).
"Roachsault," Barret Chemical Company, New York City.	- -	46.25
Martin's Pest Exterminator, Waltham, Chemical Company, Waltham, Mass.	"Nonpoisonous except to cockroaches," .	62.13
Peterman's Roach Food, Wm. Peterman, New York City.	- -	34.72
Peterman's Ant Food, Wm. Peterman, New York City.	"Do not use on animals. Caution: do not spill this powder on glassware, as it will injure the polish."	36.72
Hooper's Fatal Food, O. Hooper Jadwin, New York City.	"Only slightly poisonous," . . .	16.07

A portion of chapter 372, acts of 1911, entitled, "An Act relative to the issuance of search warrants for hypnotic drugs, and the arrest of those present," is as follows: —

Section 1. If a person makes complaint under oath to a police, district or municipal court, or to a trial justice or justice of the peace authorized to issue warrants in criminal cases, that he has reason to believe that opium, morphine, heroin, codeine, cannabis indica, cannabis sativa or any other hypnotic drug or any salt, compound or preparation of said substances is kept . . .

Section 2. Whoever is so present where any of the aforesaid drugs is found shall be punished by a fine of not more than fifty dollars or by imprisonment in the house of correction for three months.

Section 3. Whoever, not being a manufacturer or jobber of drugs, wholesale druggist, registered pharmacist, registered physician, registered veterinarian, registered dentist, registered nurse or an employee of an incorporated hospital, or otherwise entitled by law to have possession of any of the above mentioned drugs, is found in possession thereof, except by reason of a physician's prescription, shall be punished by a fine of not more than one hundred dollars or by imprisonment for six months in the house of correction.

A case recently tried in the superior court of Suffolk County was dismissed by order of the court on the ground that the words "or otherwise entitled by law to have possession of any of the above mentioned drugs" mean, under the common law, everybody. This construction of the law, if correct, absolutely nullifies it, and inasmuch as the government has no right of appeal, this probably cannot be brought to the supreme court, and it would be advisable to amend the law by eliminating this portion of it. There were two other peculiar decisions given by the lower court justices. In one case some pills were sold by a Chinaman as a cure for the opium habit. The bottle containing these pills had a label on which were printed some Chinese characters, without any designation in English or any other language, the pills containing morphine. In the lower court the defendant was declared not guilty because the quantity of morphine had not been determined by the analyst, notwithstanding the fact that the law makes no mention of the amount of morphine present in such cases. A similar decision was made by another lower court justice in a morphine seizure case.

EXAMINATIONS OF PAINTS, OILS AND TURPENTINE MADE FOR THE DISTRICT POLICE.

A law was passed this year requiring the State Board of Health to make certain analyses for the district police. As a result of this law one sample of linseed oil has been submitted for analysis. This sample was found to contain about 8 per cent. of mineral oil. The analysis of the sample is as follows: —

Specific gravity 15°, ...	0.9274
Saponification number, ...	14.8200
Iodine number, ...	190.0000
^{n}D 15°, ...	1.4815
Unsaponifiable matter, ...	9.89 per cent.

General Summary.

	Legal.	Illegal.	Total.
Milk, ...	3,777	913	4,690
Foods, exclusive of milk, ...	1,128	351	1,479
Drugs, ...	896	218	1,114
Liquor, ...	28	88	116
Poisons, ...	8	143	151
Linseed oil, ...	-	1	1
Totals, ...	5,837	1,714	7,551

Respectfully submitted,

HERMANN C. LYTHGOE.

INSPECTION OF DAIRIES.

INSPECTION OF DAIRIES.

During the year ended Nov. 30, 1911, 2,069 dairies were examined by the veterinarian of the Board, and the attention of 737 proprietors and of boards of health of the cities and towns wherein the dairies were situated, or the product thereof sold, was called to a total of 2,645 objectionable conditions. As in former years suggestions were made regarding changes considered necessary in the interest of a wholesome supply and of the public health.

Of the total number of dairies examined, 2,067 were situated in Massachusetts and 2 in neighboring States. The extra-state dairies were visited because of the fact that their product is marketed in this Commonwealth, and, if found to be other than the fresh, clean product of healthy cows, is, under the standards fixed in accordance with the provisions of the national law relative to food and drugs, to be deemed to be adulterated, and hence may not enter into interstate commerce.

The following table shows the number of dairies examined in the cities and towns visited, and the percentage found in each place to be commendable: —

Inspection of Dairies, 1911.

CITY OR TOWN.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Acushnet,	19	6	13	68.42
Second inspection,	29	6	23	79.31
Third inspection,	1	-	1	100.00
Adams,	30	10	20	66.67
Agawam,	13	3	10	76.92
Second inspection,	27	4	23	85.19
Amherst,	5	3	2	40.00
Second inspection,	10	5	5	50.00
Ashby,	29	8	21	72.41
Second inspection,	1	-	1	100.00
Third inspection,	1	-	1	100.00

Inspection of Dairies, 1911 — Continued.

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Attleborough,	8	4	4	50.00
Second inspection,	42	14	28	66.67
Avon,	1	1	-	-
Second inspection,	9	1	8	88.89
Barnstable,	7	3	4	57.14
Belchertown,	10	4	6	60.00
Second inspection,	5	2	3	60.00
Third inspection,	5	-	5	100.00
Bellingham,	27	17	10	37.04
Second inspection,	7	1	6	85.71
Berkley,	11	6	5	45.45
Second inspection,	11	4	7	63.64
Beverly,	6	3	3	50.00
Second inspection,	28	6	22	78.57
Fourth inspection,	1	-	1	100.00
Blackstone,	12	3	9	75.00
Second inspection,	13	4	9	69.23
Boylston,	2	2	-	-
Second inspection,	24	16	8	33.33
Third inspection,	1	1	-	-
Brockton,	2	1	1	50.00
Second inspection,	30	9	21	70.00
Charlemont,	9	4	5	55.56
Chatham,	9	1	8	88.89
Chelsea,[1]	4	-	4	100.00
Second inspection,	9	3	6	66.67
Third inspection,	10	4	6	60.00
Chicopee,	2	1	1	50.00
Third inspection,	4	1	3	75.00
Fourth inspection,	1	1	-	-
Colrain,	41	12	29	70.73
Dartmouth,	69	30	39	56.52
Second inspection,	102	32	70	68.63
Third inspection,	1	-	1	100.00

[1] Special investigation of all dairies.

Inspection of Dairies, 1911 — Continued.

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Dighton,	5	2	3	60.00
Second inspection,	2	1	1	50.00
Third inspection,	1	1	-	-
Dover,	2	2	-	-
Second inspection,	19	7	12	63.16
Third inspection,	1	-	1	100.00
Eastham,	5	1	4	80.00
East Longmeadow,	29	8	21	72.41
Second inspection,	10	3	7	70.00
Easton,	13	5	8	61.54
Second inspection,	30	11	19	63.33
Fairhaven,	12	5	7	58.33
Second inspection,	32	17	15	46.88
Falmouth,	15	8	7	46.67
Fitchburg,	25	11	14	56.00
Second inspection,	34	12	22	64.71
Third inspection,	2	-	2	100.00
Foxborough,	9	5	4	44.44
Second inspection,	9	3	6	66.67
Franklin,	14	6	8	57.14
Second inspection,	13	8	5	38.46
Freetown,	7	2	5	71.43
Second inspection,	6	4	2	33.33
Gloucester,	-	-	-	-
Third inspection,	1	1	-	-
Granby,	15	11	4	26.67
Second inspection,	4	2	2	50.00
Third inspection,	36	8	28	77.78
Fourth inspection,	1	-	1	100.00
Hadley,	5	4	1	20.00
Hampden,	14	1	13	92.86
Second inspection,	24	9	15	62.50
Harwich,	8	2	6	75.00
Hawley,	11	-	11	100.00
Heath,	9	2	7	77.78

Inspection of Dairies, 1911. — Continued.

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Holden,	7	6	1	14.29
Second inspection,	31	13	18	58.06
Holyoke,	3	2	1	33.33
Second inspection,	2	-	2	100.00
Third inspection,	21	7	14	66.67
Longmeadow,	4	1	3	75.00
Second inspection,	3	1	2	66.67
Lunenburg,	7	4	3	42.86
Second inspection,	38	9	29	76.32
Mansfield,	-	-	-	-
Second inspection,	15	3	12	80.00
Marion,	-	-	-	-
Second inspection,	5	-	5	100.00
Mattapoisett,	35	22	13	37.14
Second inspection,	8	4	4	50.00
Medway,	4	1	3	75.00
Second inspection,	13	4	9	69.23
Millis,	2	1	1	50.00
Milton,	3	-	3	100.00
Third inspection,	9	3	6	66.67
Monson,	4	1	3	75.00
Nantucket,	3	3	-	-
Second inspection,	34	4	30	88.24
New Bedford,	48	14	34	70.83
Second inspection,	24	8	16	66.67
Third inspection,	2	2	-	-
Norfolk,	7	1	6	85.71
Second inspection,	1	-	1	100.00
North Attleborough,	8	2	6	75.00
Second inspection,	14	1	13	92.86
Norton,	5	4	1	20.00
Second inspection,	11	5	6	54.45
Orleans,	1	-	1	100.00
Second inspection,	1	-	1	100.00
Phillipston,	3	1	2	66.67

Inspection of Dairies, 1911 — Continued.

CITY OR TOWN.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Plainville,	5	2	3	60.00
Second inspection,	8	2	6	75.00
Provincetown,	1	-	1	100.00
Second inspection,	8	-	8	100.00
Raynham,	8	4	4	50.00
Second inspection,	15	5	10	66.67
Rochester,	5	3	2	40.00
Second inspection,	3	1	2	66.67
Sandwich,	-	-	-	-
Second inspection,	15	-	15	100.00
Seekonk,	4	-	4	100.00
Second inspection,	14	8	6	42.86
Sharon,	2	-	2	100.00
Second inspection,	4	-	4	100.00
Shrewsbury,	10	3	7	70.00
Second inspection,	46	27	19	41.30
Southampton,	11	6	5	45.45
Second inspection,	15	3	12	80.00
South Hadley,	4	3	1	25.00
Second inspection,	3	1	2	66.67
Third inspection,	31	10	21	67.74
Stoughton,	22	10	12	54.55
Second inspection,	13	5	8	61.54
Sunderland,	3	2	1	33.33
Taunton,	33	16	17	51.52
Second inspection,	29	13	16	55.17
Truro,	-	-	-	-
Second inspection,	11	-	11	100.00
Uxbridge,	13	4	9	69.23
Second inspection,	19	6	13	68.42
Walpole,	39	17	22	56.41
Second inspection,	4	1	3	75.00
Wellfleet,	5	2	3	60.00
West Boylston,	17	8	9	52.94
Second inspection,	29	11	18	62.07

Inspection of Dairies, 1911 — Concluded.

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Westfield,	5	2	3	60.00
Second inspection,	4	1	3	75.00
Third inspection,	2	-	2	100.00
Westminster,	10	4	6	60.00
Second inspection,	5	1	4	80.00
West Springfield,	26	6	20	76.92
Second inspection,	10	3	7	70.00
Westwood,	2	1	1	50.00
Second inspection,	8	2	6	75.00
Wilbraham,	16	4	12	75.00
Second inspection,	9	2	7	77.78
Wrentham,	3	-	3	100.00
Yarmouth,	1	1	-	-
Miscellaneous,	30	11	19	63.33
Halifax, Vt.,	1	-	1	100.00
Whitingham, Vt.,	1	1	-	-
Outside dairies,	2	1	1	50.00
Total Massachusetts dairies,	2,067	736	1,331	64.39
Total dairies,	2,069	737	1,332	64.38

Under "Miscellaneous" are included dairies situated in the following places, in no one of which were more than 2 inspected, the examinations having been made for some special reason and not as a part of a general investigation: —

Braintree.
Lakeville.
Lexington.
Quincy.
Rehoboth.

The towns of Bourne, Brewster, Dennis and Mashpee were also visited, and it was found that the milk produced was not marketed, being only a sufficient quantity for home use; while in the towns of Rowe and Savoy the milk produced was turned into butter by the individual farmer and so consumed.

In addition to the foregoing, 702 dairies were visited at which the sale of milk had been discontinued.

NATURE OF THE DEFECTS TO WHICH ATTENTION WAS CALLED.

Below is presented an analysis of the 2,645 objectionable conditions to which the attention of boards of health was called: —

	Defects.	
CONDITION OF COWS.		
Unclean herds,	210	
	——	210
CONDITION OF BARNS.		
Dairy unfit for milk production,	8	
Barn in need of repairing,	2	
Tie-up floor in need of repairing,	17	
Tie-up in need of new floor,	1	
	——	28
Light.		
Insufficient number of windows,	92	
Windows inadequate in size,	28	
	——	120
Ventilation.		
Additional ventilation needed,	2	
Barn overcrowded,	5	
	——	7
General Cleanliness.		
General uncleanliness of premises,	238	
Tie-up in need of cleaning and whitewashing,	663	
Cobwebs,	293	
Pigs kept near cows,	131	
Swill kept near cows,	6	
Accumulated manure,	29	
Manure piled in cow tie-up,	19	
Horse manure used as bedding for cows,	7	
Horses not separated from cows,	43	
Cows kept in barn cellar,	3	
Cows kept in partial cellar,	1	
Unclean cellar,	1	
Horse manure used in vicinity of cows,	7	
Carcasses in vicinity of cows,	6	
Brewers' grains in cow tie-up,	6	
Oyster shells in cow tie-up,	1	
Cows in dark and unventilated cellar,	1	
Pigs kept in barn cellar,	1	
Lack of proper drainage,	20	
Slaughterhouse in vicinity of cows,	3	
Privy in barn,	9	
Privy near milk room,	1	
Open privy back of cows,	6	

	Defects.	
Trough back of cows used as privy,	1	
Poultry in cow tie-up,	1	
Open cesspool in vicinity of cows,	1	
Manure pit in vicinity of cows,	1	
Decaying vegetables in cow barn,	2	
Hay stored in cow tie-up,	2	
		1,503

CONDITION OF COW YARDS.

General uncleanliness,	92	
Yard in need of proper drainage,	85	
Pools of stagnant water in yard,	22	
Liquid manure in yard,	9	
Brewers' grains in yard,	1	
		209

WATER SUPPLIES.

Well exposed to surface drainage,	22	
		22

MILK ROOMS.

Milk room needed,	200	
Unclean milk room,	29	
Milk room unused,	18	
Milk room used for general storage,	3	
Milk room used as grain room,	4	
Milk room in house,	2	
Poultry in milk room,	1	
Lack of proper drainage,	6	
Insufficient light in milk room,	1	
Milk room in need of ventilation,	1	
Ice-chest in milk room unused,	1	
Milk room floor in need of repair,	1	
Change location of milk room,	1	
		268

CARE OF MILK AND MILK UTENSILS.

Milk cooled: —

(*a*) In trough,	4
(*b*) In yard,	7
(*c*) In shed,	3
(*d*) In well,	5
(*e*) Back of cows,	3
(*f*) In grain room,	1
(*g*) In house cellar,	3
(*h*) In unprotected shed,	1
(*i*) In cow tie-up,	2
(*j*) In unprotected well,	2
(*k*) In barn,	3

	Defects.		
(*l*) Near privy,	1		
(*m*) In trough back of horses,	1		
(*n*) At well house,	2		
		38	
Milk handled: —			
(*a*) In barnyard,	18		
(*b*) On barn floor,	22		
(*c*) In unprotected shed,	3		
(*d*) Back of cows,	43		
(*e*) In cow tie-up,	18		
(*f*) Back of horses,	5		
(*g*) In grain room,	5		
(*h*) In wood shed,	1		
(*i*) In barn,	48		
(*j*) In house shed,	2		
(*k*) In unclean shed,	7		
(*l*) In general storage room,	2		
		174	
Milk stored: —			
(*a*) In unclean shed,	8		
(*b*) On barn floor,	2		
(*c*) In well,	4		
(*d*) Back of cows,	3		
(*e*) In grain room,	2		
(*f*) In yard,	3		
(*g*) In unprotected shed,	1		
(*h*) In unused well where water is discolored,	1		
(*i*) Near privy,	1		
(*j*) In house cellar,	3		
(*k*) In general storage room,	1		
(*l*) In trough in cow tie-up,	1		
(*m*) In unclean and unventilated closet,	1		
(*n*) Back of horses in trough,	2		
(*o*) In barn,	1		
(*p*) In wagon shed,	1		
		35	
Unclean water in cooling trough,		2	
Cans kept in barn,		11	
Horses drink from trough in which milk is cooled,		9	
Cans aired midway between privy and house drainage,		1	
Provisions kept in refrigerator with milk,		1	
Cans washed near well,		1	
Cans inverted over sink drainage,		3	
Cows drink from trough in which milk is cooled,		2	
Unclean milk utensils,		1	
			278
Total number of objectionable features,			2,645

REPORT

UPON THE

WORK OF THE BOARD RELATIVE TO THE APPOINTMENT OF INSPECTORS OF SLAUGHTERING.

REPORT UPON THE WORK OF THE BOARD RELATIVE TO THE APPOINTMENT OF INSPECTORS OF SLAUGHTERING.

It is apparent that the work accomplished during the year 1911 has been far from complete, but it is expected with the incoming year to bring the business of slaughtering under much closer supervision by the Board.

Nominations for inspectors of slaughtering were made in 67 cities and towns. Seventeen cities and towns reported no slaughterhouse within their limits. Of the nominees approved by the Board, 1 died and 4 resigned.

An outline of the work relating to appointments of inspectors of slaughtering in the various cities and towns is given in the following tables: —

Inspectors of Slaughtering.

CITIES AND TOWNS.	Nominees appointed by Local Boards of Health.	Number of Nominees approved by State Board of Health.	Number of Nominees disapproved by State Board of Health.	Number having no Slaughter-house.	No Nomination made by Local Boards of Health.
Abington,	1	1	-	-	-
Acton,	2	1	1	-	-
Acushnet,	2	1	1	-	-
Adams,	1	1	-	-	-
Agawam,	-	-	-	1	-
Alford,	1	1	-	-	-
Amesbury,	1	1	-	-	-
Amherst,	3	3	-	-	-
Andover,	1	1	-	-	-
Arlington,	1	1	-	-	-
Ashburnham,	1	1	-	-	-
Ashby,	-	-	-	-	1
Ashfield,	3	3	-	-	-
Ashland,	1	1	-	-	-
Athol,	1	1	-	-	-
Attleborough,	1	1	-	-	-

Inspectors of Slaughtering — Continued.

CITIES AND TOWNS.	Nominees appointed by Local Boards of Health.	Number of Nominees approved by State Board of Health.	Number of Nominees disapproved by State Board of Health.	Number having no Slaughter-house.	No Nomination made by Local Boards of Health.
Auburn,	1	1	-	-	-
Avon,	1	1	-	-	-
Ayer,	-	-	-	-	1
Barnstable,	2	2	-	-	-
Barre,	1[1]	1	-	-	-
Becket,	-	-	-	-	1
Bedford,	1	1	-	-	-
Belchertown,	4	4	-	-	-
Bellingham,	1	1	-	-	-
Belmont,	-	-	-	-	1
Berkley,	-	-	-	-	1
Berlin,	1	1	-	-	-
Bernardston,	1	1	-	-	-
BEVERLY,	1	1	-	-	-
Billerica,	-	-	-	-	1
Blackstone,	1	1	-	-	-
Blandford,	2	2	-	-	-
Bolton,	1	1	-	-	-
BOSTON,	-	-	-	-	1
Bourne,	1	1	-	-	-
Boxborough,	-	-	-	-	1
Boxford,	1	1	-	-	-
Boylston,	1	1	-	-	-
Braintree,	1	-	1	-	-
Brewster,	-	-	-	1	-
Bridgewater,	1	1	-	-	-
Brimfield,	-	-	-	-	1
BROCKTON,	2	2	-	-	-
Brookfield,	-	-	-	-	1
Brookline,	-	-	-	-	1
Buckland,	-	-	-	-	1
Burlington,	-	-	-	-	1
CAMBRIDGE,	-	-	-	-	1
Canton,	-	-	-	-	1
Carlisle,	1	-	1	-	-

[1] Resigned.

Inspectors of Slaughtering — Continued.

Cities and Towns.	Nominees appointed by Local Boards of Health.	Number of Nominees approved by State Board of Health.	Number of Nominees disapproved by State Board of Health.	Number having no Slaughter-house.	No Nomination made by Local Boards of Health.
Carver,	1	1	-	-	-
Charlemont,	3	3	-	-	-
Charlton,	4	4	-	-	-
Chatham,	1	1	-	-	-
Chelmsford,	3	1	2	-	-
CHELSEA,	-	-	-	1	-
Cheshire,	1	1	-	-	-
Chester,	2	2	-	-	-
Chesterfield,	3	3	-	-	-
CHICOPEE,	2	2	-	-	-
Chilmark,	3	3	-	-	-
Clarksburg,	1	1	-	-	-
Clinton,	1	1	-	-	-
Cohasset,	1	1	-	-	-
Colrain,	1	1	-	-	-
Concord,	2	2	-	-	-
Conway,	-	-	-	-	1
Cummington,	2	2	-	-	-
Dalton,	1	1	-	-	-
Dana,	1	1	-	-	-
Danvers,	1	1	-	-	-
Dartmouth,	5	4	1	-	-
Dedham,	1	1	-	-	-
Deerfield,	1	1	-	-	-
Dennis,	-	-	-	1	-
Dighton,	1	1	-	-	-
Douglas,	1	1	-	-	-
Dover,	-	-	-	-	1
Dracut,	4	3	1	-	-
Dudley,	1	1	-	1	-
Dunstable,	1	-	1	-	-
Duxbury,	1	1	-	-	-
East Bridgewater,	1	1	-	-	-
East Longmeadow,	4	2	2	-	-
Eastham,	1	1	-	-	-

Inspectors of Slaughtering — Continued.

CITIES AND TOWNS.	Nominees appointed by Local Boards of Health.	Number of Nominees approved by State Board of Health.	Number of Nominees disapproved by State Board of Health.	Number having no Slaughter-house.	No Nomination made by Local Boards of Health.
Easthampton,	2	2	-	-	-
Easton,	2	1	1	-	-
Edgartown,	1	1	-	-	-
Egremont,	1	1	-	-	-
Enfield,	1	1	-	-	-
Erving,	2	2	-	-	-
Essex,	1	1	-	-	-
EVERETT,	-	-	-	-	1
Fairhaven,	3	1	2	-	-
FALL RIVER,	3[1]	1	-	-	-
Falmouth,	3	3	-	-	-
FITCHBURG,	1	1	-	-	-
Florida,	2	2	-	-	-
Foxborough,	1	1	-	-	-
Framingham,	-	-	-	-	1
Franklin,	2[2]	2	-	-	-
Freetown,	2	2	-	-	-
Gardner,	1	1	-	-	-
Gay Head,	-	-	-	1	-
Georgetown,	1	1	-	-	-
Gill,	1	1	-	-	-
GLOUCESTER,	-	-	-	-	1
Goshen,	-	-	-	-	1
Gosnold,	2[2]	2	-	-	-
Grafton,	1	1	-	-	-
Granby,	3	3	-	-	-
Granville,	-	-	-	-	1
Great Barrington,	2	1	1	-	-
Greenfield,	1	1	-	-	-
Greenwich,	2	2	-	-	-
Groton,	1	1	-	-	-
Groveland,	1	1	-	-	-
Hadley,	1	1	-	-	-
Halifax,	-	-	-	-	1
Hamilton,	-	-	-	-	1

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[1] Ineligible.

[2] Resigned.

Inspectors of Slaughtering — Continued.

CITIES AND TOWNS.	Nominees appointed by Local Boards of Health.	Number of Nominees approved by State Board of Health.	Number of Nominees disapproved by State Board of Health.	Number having no Slaughter-house.	No Nomination made by Local Boards of Health.
Hampden,	1	1	-	-	-
Hancock,	-	-	-	-	1
Hanover,	2	1	1	-	-
Hanson,	2	2	-	-	-
Hardwick,	1	1	-	-	-
Harvard,	1	-	1	-	-
Harwich,	1	1	-	-	-
Hatfield,	2	2	-	-	-
HAVERHILL,	1	1	-	-	-
Hawley,	3	2	1	-	-
Heath,	2	2	-	-	-
Hingham,	1	1	-	-	-
Hinsdale,	1	1	-	-	-
Holbrook,	-	-	-	-	1
Holden,	4	4	-	-	-
Holland,	1	1	-	-	-
Holliston,	1	1	-	-	-
HOLYOKE,	1	1	-	-	-
Hopedale,	-	-	-	-	1
Hopkinton,	-	-	-	-	1
Hubbardston,	1	1	-	-	-
Hudson,	1	1	-	-	-
Hull,	-	-	-	-	1
Huntington,	2	1	1	-	-
Hyde Park,	-	-	-	-	1
Ipswich,	2[1]	-	1	-	-
Kingston,	1	1	-	-	-
Lakeville,	1	-	1	-	-
Lancaster,	1	1	-	-	-
Lanesborough,	1	1	-	-	-
LAWRENCE,	-	-	-	-	1
Lee,	-	-	-	-	1
Leicester,	2	2	-	-	-
Lenox,	1	1	-	-	-
Leominster,	1	1	-	-	-

[1] Ineligible.

Inspectors of Slaughtering — Continued.

CITIES AND TOWNS.	Nominees appointed by Local Boards of Health.	Number of Nominees approved by State Board of Health.	Number of Nominees disapproved by State Board of Health.	Number having no Slaughter-house.	No Nomination made by Local Boards of Health.
Leverett,	-	-	-	1	-
Lexington,	1	1	-	-	-
Leyden,	1	1	-	-	-
Lincoln,	1	-	1	-	-
Littleton,	-	-	-	-	1
Longmeadow,	-	-	-	-	1
LOWELL,	1	1	-	-	-
Ludlow,	2	2	-	-	-
Lunenburg,	1	1	-	-	-
LYNN,	-	-	-	-	1
Lynnfield,	1	-	1	-	-
MALDEN,	-	-	-	-	1
Manchester,	1	1	-	-	-
Mansfield,	1	1	-	-	-
Marblehead,	1	1	-	-	-
Marion,	1	1	-	-	-
MARLBOROUGH,	2	2	-	-	-
Marshfield,	1	1	-	-	-
Mashpee,	-	-	-	1	-
Mattapoisett,	2	2	-	-	-
Maynard,	1	1	-	-	-
Medfield,	1	1	-	-	-
MEDFORD,	-	-	-	1	-
Medway,	1	1	-	-	-
MELROSE,	1	1	-	-	-
Mendon,	1	1	-	-	-
Merrimac,	-	-	-	-	1
Methuen,	1	1	-	-	-
Middleborough,	1	1	-	-	-
Middlefield,	1	1	-	-	-
Middleton,	1	1	-	-	-
Milford,	1	1	-	-	-
Millbury,	-	-	-	-	1
Millis,	1	1	-	-	-
Milton,	1	1	-	-	-

Inspectors of Slaughtering — Continued.

CITIES AND TOWNS.	Nominees appointed by Local Boards of Health.	Number of Nominees approved by State Board of Health.	Number of Nominees disapproved by State Board of Health.	Number having no Slaughter-house.	No Nomination made by Local Boards of Health.
Monroe,	-	-	-	1	-
Monson,	1	1	-	-	-
Montague,	4	4	-	-	-
Monterey,	3	3	-	-	-
Montgomery,	-	-	-	-	1
Mount Washington,	-	-	-	1	-
Nahant,	-	-	-	-	1
Nantucket,	1	1	-	-	-
Natick,	-	-	-	-	1
Needham,	1	1	-	-	-
New Ashford,	1	1	-	-	-
NEW BEDFORD,	1	1	-	-	-
New Braintree,	-	-	-	-	1
New Marlborough,	2	2	-	-	-
New Salem,	1	1	-	-	-
Newbury,	1	1	-	-	-
NEWBURYPORT,	-	-	-	-	1
NEWTON,	-	-	-	-	1
Norfolk,	1	-	1	-	-
NORTH ADAMS,	2	2	-	-	-
North Andover,	-	-	-	-	1
North Attleborough,	1	1	-	-	-
North Brookfield,	1	1	-	-	-
North Reading,	1	1	-	-	-
NORTHAMPTON,	1	1	-	-	-
Northborough,	-	-	-	-	1
Northbridge,	-	-	-	1	-
Northfield,	-	-	-	-	1
Norton,	1	-	1	-	-
Norwell,	1	1	-	-	-
Norwood,	1	1	-	-	-
Oak Bluffs,	1	1	-	-	-
Oakham,	1	1	-	-	-
Orange,	1	1	-	-	-
Orleans,	-	-	-	-	1

Inspectors of Slaughtering — Continued.

CITIES AND TOWNS.	Nominees appointed by Local Boards of Health.	Number of Nominees approved by State Board of Health.	Number of Nominees disapproved by State Board of Health.	Number having no Slaughter-house.	No Nomination made by Local Boards of Health.
Otis,	1	1	-	-	-
Oxford,	-	-	-	-	1
Palmer,	-	-	-	-	1
Paxton,	1	1	-	-	-
Peabody,	1	1	-	-	-
Pelham,	-	-	-	1	-
Pembroke,	1	1	-	-	-
Pepperell,	1	1	-	-	-
Peru,	1	1	-	-	-
Petersham,	-	-	-	-	1
Phillipston,	1	1	-	-	-
PITTSFIELD,	1	1	-	-	-
Plainfield,	1	1	-	-	-
Plainville,	1	1	-	-	-
Plymouth,	1	1	-	-	-
Plympton,	1	1	-	-	-
Prescott,	2	2	-	-	-
Princeton,	1	1	-	-	-
Provincetown,	2	2	-	-	-
QUINCY,	-	-	-	-	1
Randolph,	1	-	1	-	-
Raynham,	3	1	2	-	-
Reading,	2	2	-	-	-
Rehoboth,	1	1	-	-	-
Revere,	-	-	-	-	1
Richmond,	-	-	-	-	1
Rochester,	2	2	-	-	-
Rockland,	1	1	-	-	-
Rockport,	-	-	-	1	-
Rowe,	1	1	-	-	-
Rowley,	2	2	-	-	-
Royalston,	4	4	-	-	-
Russell,	2	2	-	-	-
Rutland,	-	-	-	-	1
SALEM,	1	1	-	-	-

Inspectors of Slaughtering—Continued.

CITIES AND TOWNS.	Nominees appointed by Local Boards of Health.	Number of Nominees approved by State Board of Health.	Number of Nominees disapproved by State Board of Health.	Number having no Slaughter-house.	No Nomination made by Local Boards of Health.
Salisbury,	1	1	-	-	-
Sandisfield,	2	2	-	-	-
Sandwich,	4	1	3	-	-
Saugus,	1	1	-	-	-
Savoy,	-	-	-	1	-
Scituate,	1	1	-	-	-
Seekonk,	1	1	-	-	-
Sharon,	1	1	-	-	-
Sheffield,	2	2	-	-	-
Shelburne,	3	3	-	-	-
Sherborn,	1	1	-	-	-
Shirley,	-	-	-	-	1
Shrewsbury,	1	1	-	-	-
Shutesbury,	1	1	-	-	-
Somerset,	1	1	-	-	-
SOMERVILLE,	1	1	-	-	-
South Hadley,	1	1	-	-	-
Southampton,	2[1]	2	-	-	-
Southborough,	-	-	-	-	1
Southbridge,	1	1	-	-	-
Southwick,	3	3	-	-	-
Spencer,	1	1	-	-	-
SPRINGFIELD,	1	1	-	-	-
Sterling,	1	1	-	-	-
Stockbridge,	3	2	1	-	-
Stoneham,	1	1	-	-	-
Stoughton,	1	1	-	-	-
Stow,	1	1	-	-	-
Sturbridge,	-	-	-	-	1
Sudbury,	1	1	-	-	-
Sunderland,	1	1	-	-	-
Sutton,	3	3	-	-	-
Swampscott,	2	2	-	-	-
Swansea,	2	2	-	-	-
TAUNTON,	2	2	-	-	-

[1] Resigned.

Inspectors of Slaughtering — Continued.

CITIES AND TOWNS.	Nominees appointed by Local Boards of Health.	Number of Nominees approved by State Board of Health.	Number of Nominees disapproved by State Board of Health.	Number having no Slaughter-house.	No Nomination made by Local Boards of Health.
Templeton,	3	2	1	-	-
Tewksbury,	1	1	-	-	-
Tisbury,	1	1	-	-	-
Tolland,	-	-	-	-	1
Topsfield,	1	1	-	-	-
Townsend,	1	1	-	-	-
Truro,	1	1	-	-	-
Tyngsborough,	1	1	-	-	-
Tyringham,	1	1	-	-	-
Upton,	1	1	-	-	-
Uxbridge,	1	1	-	-	-
Wakefield,	-	-	-	-	1
Wales,	1	1	-	-	-
Walpole,	1	-	1	-	-
WALTHAM,	1	1	-	-	-
Ware,	2	2	-	-	-
Wareham,	1	1	-	-	-
Warren,	1	1	-	-	-
Warwick,	-	-	-	-	1
Washington,	1	1	-	-	-
Watertown,	1	1	-	-	-
Wayland,	2	-	2	-	-
Webster,	-	-	-	-	1
Wellesley,	1	1	-	-	-
Wellfleet,	1	1	-	-	-
Wendell,	2	2	-	-	-
Wenham,	1	-	1	-	-
West Boylston,	2[1]	2	-	-	-
West Bridgewater,	1	1	-	-	-
West Brookfield,	1	1	-	-	-
West Newbury,	1	1	-	-	-
West Springfield,	-	-	-	-	1
West Stockbridge,	1	1	-	-	-
West Tisbury,	1	1	-	-	-
Westborough,	-	-	-	-	1
Westfield,	2	2	-	-	-

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[1] Deceased.

Inspectors of Slaughtering — Concluded.

CITIES AND TOWNS.	Nominees appointed by Local Boards of Health.	Number of Nominees approved by State Board of Health.	Number of Nominees disapproved by State Board of Health.	Number having no Slaughter-house.	No Nomination made by Local Boards of Health.
Westford,	1	1	-	-	-
Westhampton,	-	-	-	1	-
Westminster,	2	2	-	-	-
Weston,	1	1	-	-	-
Westport,	5	5	-	-	-
Westwood,	1	1	-	-	-
Weymouth,	1	1	-	-	-
Whately,	1	1	-	-	-
Whitman,	1	1	-	-	-
Wilbraham,	2	2	-	-	-
Williamsburg,	1	1	-	-	-
Williamstown,	1	1	-	-	-
Wilmington,	1	1	-	-	-
Winchendon,	1	1	-	-	-
Winchester,	-	-	-	1	-
Windsor,	-	-	-	-	1
Winthrop,	-	-	-	-	1
WOBURN,	1	1	-	-	-
WORCESTER,	-	-	-	-	1
Worthington,	1	1	-	-	-
Wrentham,	-	-	-	-	1
Yarmouth,	3	3	-	-	-
Totals,	389	349	37	17	68

Summary.

Number of nominations made by local boards of health,	389
Number of nominees approved by State Board of Health,	349
Number of nominees disapproved by State Board of Health,	37
Number ineligible for reasons of law,	3

Reasons for Disapproval.

Lack of general qualifications,	7
Would have to inspect own meat,	17
Untrustworthy or inefficient,	11
Incapacitated on account of age,	1
Objects to being present at time of slaughter (averse to seeing animals killed),	1
	37

EXAMINATION OF PLUMBERS.

EXAMINATION OF PLUMBERS.

State Board of Health, Commonwealth of Massachusetts, Boston, Mass.

GENTLEMEN: — Pursuant to the requirements of section 3, chapter 536, Acts of 1909, the State Examiners of Plumbers respectfully submit the following report of their affairs for the year ending Nov. 30, 1911: —

EXAMINATIONS.	Examined.	Passed.	Refused.
Boston, Dec. 3, 1910,	74	18	56
Lowell, Dec. 17, 1910,	25	8	17
Boston, Jan. 7, 1911,	57	12	45
Pittsfield, Jan. 21, 1911,	26	6	20
Boston, Feb. 4, 1911,	59	11	48
Springfield, Feb. 18, 1911,	59	19	40
Boston, March 4, 1911,	69	22	47
Fall River, March 18, 1911,	46	16	30
Boston, April 1, 1911,	79	23	56
Worcester, April 18, 1911,	32	14	18
Boston, May 6, 1911,	80	30	50
Lowell, May 20, 1911,	29	11	18
Boston, June 3, 1911,	89	25	64
Pittsfield, June 17, 1911,	35	12	23
Boston, July 1, 1911,	63	18	45
Boston, Sept. 2, 1911,	74	22	52
Springfield, Sept. 16, 1911,	47	14	33
Boston, Oct. 7, 1911,	80	21	59
Fall River, Oct. 21, 1911,	28	5	23
Boston, Nov. 4, 1911,	32	9	23
Worcester, Nov. 18, 1911,	19	10	9
	1,102	326	776

	Masters.	Journeymen.	Total.
Licenses granted on account of examinations December, 1910, to December, 1911.	64	262	326
Probationary licenses issued during the year,	-	-	25

REGISTRATIONS.	Masters.	Journeymen
December, 1910,	18	36
January, 1911,	10	26
February, 1911,	8	21
March, 1911,	11	39
April, 1911,	5	23
May, 1911,	18	73
June, 1911,	8	31
July, 1911,	7	39
August, 1911,	11	28
September, 1911,	9	31
October, 1911,	2	29
November, 1911,	11	16
Totals,	118	392

Meetings,	72	Examinations,	21

FEES RECEIVED.	Paid to the Treasurer of the Commonwealth.
1,102 examination fees, at $0.50,	$551 00
118 master plumber licenses, at $2,	236 00
392 journeyman plumber licenses, at $0.50,	196 00
1,496 master plumber licenses (renewals), at $0.50,	748 00
3,008 journeyman plumber licenses (renewals), at $0.50,	1,504 00
	$3,235 00

Summary of Registrations.

	Masters.	Journeymen.
Certificate holders,	521	507
Licensed for year ending May 1, 1912,	1,561	2,136
	2,082	2,643

Expenses.

Salary, clerk,	$2,000 00
Wages, first and second examiners,	680 00
Traveling expenses,	490 72
Express charges,	29 16
Printing,	317 07
Postage,	174 14
Books and stationery,	219 79
Plumbing material,	39 75
Cleaning,	21 50
Extra services,	875 61
Miscellaneous (telephone call),	20
	$4,847 94

Deceased Plumbers (reported to Examiners).

Masters,	27	Journeymen,	20

PLUMBING RULES.

Conforming to the requirements of section 5, chapter 536, Acts of 1909, plumbing rules were formulated by the State Examiners of Plumbers and, being approved by the State Board of Health (Jan. 5, 1911), copies were forwarded to the boards of health of 9 towns, they having petitioned the examiners for plumbing rules.

Rules formulated by the State Examiners of Plumbers have been adopted by the following towns: Athol, Barnstable, Braintree, Easthampton, Lancaster, Natick, Rockland.

In our report of last year attention was called by the examiners to the probable deficit of current and coming years. The deficit for this year is $1,612, and this deficit will continue unless legislation allowing for increased fees be enacted. The present fees as fixed by statute are $2 for master plumber's license, 50 cents for journeyman plumber's license, with renewals at 50 cents each for both master and journeyman. Examination fee is 50 cents for all classes of license. The examiners believe that the Board should be self-supporting, but to bring this about a slight adjustment of fees should be made, authority for which can be given only by the Legislature. We, therefore, renew our recommendation of last year that the examiners be given authority to fix the fees subject to the approval of the State Board of Health, the fee for master plumber's license not to exceed $2 per year, and the fee for journeyman plumber's license not to exceed $1 per year.

JAMES C. COFFEY.
CHAS. R. FELTON.
EDWARD C. KELLY.

REPORT

UPON THE

PRODUCTION AND DISTRIBUTION OF DIPHTHERIA ANTITOXIN AND VACCINE VIRUS

FOR THE

YEAR ENDED NOV. 30, 1911.

REPORT

UPON THE

PRODUCTION AND DISTRIBUTION OF DIPHTHERIA ANTITOXIN AND VACCINE VIRUS

FOR THE

YEAR ENDED NOV. 30, 1911.

The production of diphtheria antitoxin and vaccine has continued under the direction of Dr. Theobald Smith, at the laboratory of the State Board of Health at Forest Hills. The distribution has been conducted, as before, at the office of the Board.

The total number of packages issued by the Board during the sixteen years and eight months ended Nov. 30, 1911, was as follows: —

	Bottles.
In 1895–1896 (year ended March 31),	1,724
In 1896–1897 (year ended March 31),	3,219
In 1897–1898 (year ended March 31),	4,668
In 1898–1899 (year ended March 31),	12,491
In 1899–1900 (year ended March 31),	31,997
In 1900–1901 (year ended March 31),	53,389
In 1901–1902 (year ended March 31),	40,211
In 1902–1903 (year ended March 31),	33,475
In 1903–1904 (year ended March 31),	41,133
During six months ended Sept. 30, 1904,	22,255
In 1904–1905 (year ended Sept. 30, 1905),	47,387
During fourteen months ended Nov. 30, 1906,	70,424
In 1906–1907 (year ended Nov. 30, 1907),	64,807
In 1907–1908 (year ended Nov. 30, 1908),	94,645
In 1908–1909 (year ended Nov. 30, 1909),	90,131
In 1909–1910 (year ended Nov. 30, 1910),	92,623
In 1910–1911 (year ended Nov. 30, 1911),	96,522
Total,	801,101

The serum was distributed to local boards of health, to hospitals and to practitioners in 202 cities and towns, 59 of which used more than 100 bottles each. The following table shows the distribution: —

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1910, to Nov. 30, 1911.

CITY OR TOWN.	Number of Bottles.	CITY OR TOWN.	Number of Bottles.
Acton,	30	Braintree,	24
Adams,	157	Brewster,	18
Agawam,	24	Bridgewater,	39
Amesbury,	92	Brimfield,	12
Amherst,	27	Brockton,	303
Andover,	24	Brookfield,	2
Arlington,	350	Brookline,	368
Ashburnham,	36	Cambridge,	1,200
Athol,	72	Hospital for Contagious Diseases,	1,163
Attleborough,	96	Hospital,	74
Ayer,	36	Stillman Infirmary,	60
Barnstable,	12	Canton,	99
Barre,	12	Massachusetts Hospital for Crippled and Deformed Children.	15
Becket,	30	Charlemont,	6
Bedford,	76	Chelsea,	370
Belmont,	12	United States Marine Hospital,	24
Massachusetts School for the Feeble-minded.	12	Cheshire,	6
McLean Hospital,	6	Chester,	26
Beverly,	60	Chesterfield,	6
Blackstone,	297	Chicopee,	111
Blandford,	6	Clinton,	155
Boston: —		Cohasset,	18
Boston Floating Hospital,	14	Concord,	72
Boston Lying-in Hospital,	18	Conway,	3
Children's Hospital,	1,450	Cummington,	6
City Hospital,	41,573	Dalton,	36
General Supply,	9,009	Danvers,	91
Infants' Hospital,	72	Dedham,	78
Massachusetts Charitable Eye and Ear Infirmary.	30	Deerfield,	12
Massachusetts General Hospital,	100	Dennis,	6
Massachusetts Homoeopathic Hospital.	4,495	Dighton,	36
Massachusetts Infant Asylum,	3	Douglas,	18
St. Elizabeth's Hospital,	10	Dudley,	18
St. Mary's Infant Asylum,	331	Duxbury,	12
Training ship "Ranger,"	24	East Bridgewater,	42
Bourne,	24	Easthampton,	132

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1910, to Nov. 30, 1911 — Continued.

CITY OR TOWN.	Number of Bottles.	CITY OR TOWN.	Number of Bottles.
Easton,	42	Leominster,	140
Everett,	540	Lexington,	79
Fairhaven,	24	Littleton,	12
Fall River,	1,156	Lowell,	1,053
Fitchburg,	1,805	Ludlow,	30
Foxborough,	87	Lynn,	1,056
Framingham,	72	Hospital for Contagious Diseases,	1,700
Franklin,	18	Malden,	739
Gardner,	48	Manchester,	12
Georgetown,	12	Mansfield,	132
Gloucester,	261	Marblehead,	12
Grafton,	12	Children's Island Sanatorium,	37
Great Barrington,	6	Marion,	6
Greenfield,	42	Marlborough,	149
Hamilton,	12	Mattapoisett,	6
Hampden,	6	Maynard,	73
Hanover,	6	Medfield,	42
Hanson,	12	State Asylum,	75
Hardwick,	109	Medford,	218
Harvard,	12	Medway,	6
Haverhill,	938	Melrose,	62
Hingham,	36	Merrimac,	12
Holden,	6	Methuen,	54
Holliston,	6	Middleborough,	30
Holyoke,	419	Milford,	73
Hopedale,	25	Millbury,	49
Hopkinton,	6	Millis,	6
Hudson,	36	Milton,	30
Hull,	36	Monson,	12
Huntington,	12	State Hospital,	6
Hyde Park,	201	Montague,	99
Ipswich,	66	Nantucket,	12
Kingston,	12	Natick,	60
Lawrence,	1,623	Needham,	30
Leicester,	48	New Bedford,	880
Lenox,	37	Newburyport,	315

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1910, to Nov. 30, 1911 — Continued.

City or Town.	Number of Bottles.
Newton,	100
Hospital,	450
North Adams,	225
North Andover,	24
North Attleborough,	97
North Brookfield,	12
Northampton,	477
Northbridge,	40
Northfield,	15
Norton,	2
Norwell,	6
Norwood,	205
Orange,	138
Oxford,	6
Palmer,	132
Peabody,	146
Petersham,	12
Pepperell,	48
Pittsfield,	633
Plymouth,	42
Provincetown,	67
Quincy,	696
Randolph,	50
Reading,	73
Revere,	303
Rockport,	18
Rowley,	27
Salem,	835
Salisbury,	12
Sandisfield,	12
Saugus,	223
Scituate,	12
Sharon,	18
Shirley: —	
State Industrial School for Boys,	12
Somerville,	1,466
Hospital for Contagious Diseases,	2,472
Southborough,	15
Southbridge,	42
Southwick,	6
Springfield,	986
Sterling,	20
Stoneham,	36
Stoughton,	48
Stow,	62
Sturbridge,	6
Swampscott,	18
Taunton,	302
Templeton,	6
Tewksbury,	70
Tisbury,	6
Topsfield,	6
Townsend,	6
Truro,	6
Uxbridge,	36
Wakefield,	269
Walpole,	23
Waltham,	235
Hospital,	1,034
Ware,	86
Warren,	18
Watertown,	154
Wayland,	6
Webster,	139
Wellesley,	12
Wenham,	12
West Boylston,	6
West Bridgewater,	12
West Brookfield,	7
West Springfield,	60
Westborough,	24
Westfield,	109
Westford,	11
Westminster,	12

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1910, to Nov. 30, 1911 — Concluded.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Westport,	36	**Winchester**,	12
Weymouth,	203	**Winthrop**,	308
Whitman,	104	**Fort Banks**,	24
Williamsburg,	6	**Woburn**,	192
Williamstown,	126	**Worcester**,	3,875
Wilmington,	15	**Yarmouth**,	5
Winchendon,	227	**Total**,	96,522

The total number of tubes of vaccine virus issued by the Board during the seven years and two months ended Nov. 30, 1911, was as follows: —

	Tubes.
In 1904–1905 (year ended Sept. 30, 1905),	23,970
During fourteen months ended Nov. 30, 1906,	31,805
In 1906–1907 (year ended Nov. 30, 1907),	45,265
In 1907–1908 (year ended Nov. 30, 1908),	48,768
In 1908–1909 (year ended Nov. 30, 1909),	47,961
In 1909–1910 (year ended Nov. 30, 1910),	76,690
In 1910–1911 (year ended Nov. 30, 1911),	65,251
Total,	339,710

The vaccine virus was distributed as shown in the following table: —

Number of Tubes of Vaccine distributed from Dec. 1, 1910, to Nov. 30, 1911.

City or Town.	Number of Tubes.	City or Town.	Number of Tubes.
Abington,	60	**Bedford**,	40
Acton,	52	**Belmont**,	10
Amesbury,	691	**Massachusetts School for the Feeble-minded.**	100
Andover,	28	**Beverly**,	58
Arlington,	393	**Boston**: —	
Ashby,	11	**City Hospital**,	1,390
Attleborough,	560	**General supply**,	15,610
Ayer,	81	**Infants' Hospital**,	168

Number of Tubes of Vaccine distributed from Dec. 1, 1910, to Nov. 30, 1911 — Continued.

CITY OR TOWN.	Number of Tubes.	CITY OR TOWN.	Number of Tubes.
Boston — *Con.*		Granville,	80
Massachusetts General Hospital,	175	Groton,	32
Massachusetts Homœopathic Hospital.	450	Hamilton,	65
Penal institutions,	1,150	Hanover,	18
Bourne,	35	Hingham,	200
Braintree,	111	Holbrook,	30
Bridgewater,	190	Holden,	60
Brimfield,	57	Hopkinton,	12
Brockton,	552	Hudson,	15
Brookline,	723	Hull,	50
Cambridge,	1,645	Hyde Park,	265
Canton,	27	Kingston,	5
Charlemont,	200	Lawrence,	3,747
Chatham,	120	Lee,	55
Chelmsford,	95	Leicester,	20
Chelsea,	1,238	Lexington,	124
Chesterfield,	45	Lincoln,	20
Chicopee,	524	Lowell,	1,810
Clinton,	500	Ludlow,	35
Cohasset,	101	Lynn,	2,155
Concord,	155	Malden,	527
Massachusetts Reformatory,	700	Mansfield,	65
Danvers,	208	Marblehead,	173
Dedham,	638	Marshfield,	40
Dudley,	70	Medfield,	33
Duxbury,	33	Medford,	201
East Bridgewater,	105	Medway,	23
Easton,	146	Melrose,	300
Everett,	391	Merrimac,	30
Fall River,	5,850	Methuen,	170
Falmouth,	12	Milford,	230
Fitchburg,	900	Millbury,	360
Foxborough,	101	Millis,	50
Freetown,	25	Milton,	81
Gardner,	15	Monson: —	
Georgetown,	25	State Hospital,	250
Gloucester,	355	Nantucket,	20

Number of Tubes of Vaccine distributed from Dec. 1, 1910, to Nov. 30, 1911 — Concluded.

CITY OR TOWN.	Number of Tubes.	CITY OR TOWN.	Number of Tubes.
Needham,	255	Topsfield,	26
Newton,	750	Townsend,	53
North Adams,	335	Wakefield,	355
North Andover,	88	Walpole,	126
North Attleborough,	257	Waltham,	401
North Reading,	20	Ware,	50
Norwood,	343	Wareham,	10
Orange,	50	Watertown,	151
Oxford,	340	Wayland,	30
Palmer,	180	Webster,	50
Pembroke,	18	Wellesley,	181
Pittsfield,	35	Wenham,	12
Plymouth,	98	West Brookfield,	85
Provincetown,	12	West Newbury,	29
Quincy,	1,247	West Springfield,	15
Randolph,	58	West Stockbridge,	140
Revere,	431	Westborough: —	
Richmond,	25	State Hospital,	3
Rockland,	160	Westfield,	325
Salem,	553	Westford,	78
Scituate,	9	Westminster,	30
Sharon,	16	Westport,	107
Sherborn,	30	Weymouth,	346
State Reformatory,	12	Whitman,	27
Somerville,	1,460	Williamstown,	90
Southborough,	40	Wilmington,	73
Southwick,	25	Winchester,	105
Springfield,	1,610	Winthrop,	205
Stoneham,	65	Woburn,	246
Stoughton,	40	Worcester,	2,250
Swampscott,	150	Wrentham: —	
Taunton,	1,850	State School,	250
State Hospital,	520	Total,	65,251
Tewksbury: —			
State Hospital,	50		

REPORT

UPON THE

WORK OF THE BACTERIOLOGICAL LABORATORY

FOR THE

YEAR ENDED NOV. 30, 1911.

Report upon Diphtheria Cultures examined during the Year ended Nov. 30, 1911.

From Dec. 1, 1910, to Nov. 30, 1911, 4,368 cultures were received from 163 cities and towns in the State. Of these cultures, 2,631 were for the purpose of diagnosis and 1,737 were for release from quarantine.

The following table gives the number of cultures received from the different cities and towns and the results of the examinations: —

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Abington,	3	-	1	2
Acton,	7	2	2	3
Adams,	2	2	-	-
Amesbury,	24	3	4	17
Amherst,	6	1	3	2
Andover,	6	-	6	-
Arlington,	53	4	18	31
Ashburnham,	11	1	2	8
Ashland,	7	2	5	-
Athol,	82	14	15	53
Attleborough,	35	5	18	12
Ayer,	4	-	2	2
Barnstable,	5	1	1	3
Becket,	2	-	-	2
Bedford,	11	1	4	6
Belmont,	17	4	13	-
Beverly,	39	4	16	19
Blackstone,	3	2	1	-
Boston,	11	2	9	-
Bourne,	15	3	3	9
Boxborough,	2	-	2	-
Braintree,	9	1	6	2
Brewster,	4	1	2	1
Bridgewater,	12	3	6	3

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Brimfield,	6	-	4	2
Canton,	16	3	9	4
Carlisle,	4	1	1	2
Charlemont,	1	-	1	-
Chelmsford,	8	-	-	8
Chelsea,	254	33	38	183
Cohasset,	10	-	9	1
Concord,	35	5	11	19
Danvers,	10	1	6	3
Dedham,	30	5	20	5
Douglas,	17	5	1	11
Dover,	1	1	-	-
Dudley,	4	1	1	2
Duxbury,	7	2	3	2
East Bridgewater,	15	3	4	8
Edgartown,	1	-	1	-
Everett,	176	43	69	64
Falmouth,	1	-	1	-
Fitchburg,	2	-	-	2
Foxborough,	78	10	34	34
Framingham,	38	9	16	13
Franklin,	6	2	-	4
Great Barrington,	8	1	3	4
Groton,	2	-	2	-
Hamilton,	4	2	1	1
Hanover,	3	-	3	-
Hanson,	2	-	1	1
Harvard,	6	-	6	-
Hingham,	34	2	24	8
Holbrook,	3	-	3	-
Hudson,	15	2	11	2
Hull,	15	2	11	2
Hyde Park,	1	-	1	-
Ipswich,	29	4	7	18
Kingston,	3	2	1	-
Lawrence,	3	-	3	-
Lincoln,	3	-	3	-
Ludlow,	2	-	2	-

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Lynn,	2	-	-	2
Lynnfield,	3	-	2	1
Malden,	1	-	1	-
Manchester,	6	2	1	3
Mansfield,	84	17	22	45
Marblehead,	29	6	13	10
Marion,	1	1	-	-
Marlborough,	75	17	29	29
Maynard,	54	5	33	16
Medfield,	768	36	597	135
Medford,	144	27	55	62
Medway,	8	3	2	3
Melrose,	186	25	109	52
Merrimac,	13	-	3	10
Methuen,	7	2	4	1
Middleborough,	36	5	3	28
Middleton,	1	-	1	-
Milford,	1	-	1	-
Millis,	3	-	3	-
Milton,	56	5	37	14
Monson,	2	-	2	-
Montague,	1	-	1	-
Natick,	19	7	7	5
Needham,	13	4	7	2
New Bedford,	1	-	1	-
Newburyport,	19	5	9	5
Norfolk,	3	-	-	3
North Adams,	1	-	1	-
North Attleborough,	45	15	17	13
North Brookfield,	2	-	2	-
North Reading,	4	-	4	-
Northbridge,	3	1	2	-
Northfield,	2	-	2	-
Norton,	1	-	1	-
Norwell,	13	-	4	9
Norwood,	86	16	26	44
Orange,	35	6	1	28
Oxford,	3	1	1	1

City or Town.	Whole Number of Cultures examin.d.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Palmer,	2	-	2	-
Peabody,	45	10	12	23
Pepperell,	9	2	1	6
Petersham,	1	-	1	-
Phillipston,	1	-	1	-
Plainville,	1	-	1	-
Plymouth,	9	1	6	2
Provincetown,	4	1	-	3
Quincy,	73	23	39	11
Randolph,	4	2	1	1
Reading,	16	1	10	5
Revere,	95	14	53	28
Rochester,	9	-	-	9
Rockland,	8	1	5	2
Rockport,	12	1	7	4
Rowe,	3	-	-	3
Rowley,	3	1	2	-
Royalston,	1	1	-	-
Salem,	172	21	31	119
Sandwich,	3	2	1	-
Saugus,	76	10	39	28
Scituate,	11	1	5	5
Sharon,	13	2	9	2
Shelburne,	3	1	1	1
Sherborn,	2	-	2	-
Shirley,	7	-	7	-
Somerville,	1	-	1	-
Southborough,	1	-	1	-
Southbridge,	14	-	6	8
Spencer,	4	-	2	2
Sterling,	1	-	-	1
Stoneham,	15	2	10	3
Stoughton,	55	12	13	30
Sturbridge,	1	1	-	-
Swampscott,	4	-	-	4
Taunton,	56	20	22	14
Templeton,	11	2	3	6
Topsfield,	3	-	3	-

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Truro,	2	-	1	1
Uxbridge,	1	1	-	-
Wakefield,	47	16	16	15
Walpole,	27	6	11	10
Waltham,	2	-	1	1
Wareham,	3	-	3	-
Warren,	6	-	5	1
Watertown,	75	17	20	38
Webster,	40	13	5	22
Wenham,	6	1	4	1
West Boylston,	1	-	1	-
West Brookfield,	3	1	-	2
Westborough,	18	2	12	4
Westfield,	2	2	-	-
Westford,	5	1	2	2
Westport,	5	-	5	-
Weymouth,	37	8	20	9
Whitman,	15	2	5	8
Williamstown,	44	14	7	23
Wilmington,	5	2	1	2
Winchendon,	98	23	22	53
Winchester,	14	-	11	3
Winthrop,	131	17	43	71
Woburn,	77	9	16	52
Wrentham,	1	-	1	-
Totals,	4,368	668	1,963	1,737

REPORT UPON THE EXAMINATION OF SPUTUM AND OTHER MATERIAL SUSPECTED OF CONTAINING THE BACILLI OF TUBERCULOSIS.

From Dec. 1, 1910, to Nov. 30, 1911, microscopical examination has been made of 2,383 lots of sputum and other material suspected of containing the bacilli of tuberculosis. This material has been received from 179 cities and towns in the State. The following table gives the places from which the material has been received and the results of the microscopical examination: —

City or Town.	Whole Number of Examinations.	Positive.	Negative.	City or Town.	Whole Number of Examinations.	Positive.	Negative.
Abington,	11	1	10	Blackstone,	18	7	11
Acton,	4	2	2	Boston,	193	152	41
Adams,	26	6	20	Bourne,	5	2	3
Amesbury,	22	4	18	Braintree,	9	2	7
Amherst,	1	1	-	Bridgewater,	19	7	12
Andover,	5	-	5	Brimfield,	1	1	-
Arlington,	27	4	23	Brookfield,	1	-	1
Ashby,	1	1	-	Burlington,	2	1	1
Ashland,	12	-	12	Cambridge,	2	-	2
Athol,	17	4	13	Canton,	6	-	6
Attleborough,	81	17	64	Carlisle,	1	-	1
Auburn,	1	-	1	Charlemont,	1	-	1
Avon,	5	2	3	Chatham,	1	-	1
Ayer,	1	-	1	Chelmsford,	6	3	3
Barnstable,	4	2	2	Chelsea,	94	20	74
Becket,	1	1	-	Chesterfield,	5	3	2
Bedford,	4	1	3	Clarksburg,	1	1	-
Belmont,	11	2	9	Cohasset,	18	7	11
Beverly,	17	5	12	Concord,	7	2	5
Billerica,	1	1	-	Cummington,	1	-	1

CITY OR TOWN.	Whole Number of Examinations.	Positive.	Negative.	CITY OR TOWN.	Whole Number of Examinations.	Positive.	Negative.
Danvers,	40	11	29	Ipswich,	20	5	15
Dedham,	40	13	27	Lawrence,	55	38	17
Dennis,	6	2	4	Lee,	2	2	-
Dighton,	1	1	-	Lenox,	2	1	1
Duxbury,	4	3	1	Lexington,	20	2	18
East Bridgewater,	8	3	5	Lowell,	1	-	1
East Longmeadow,	2	-	2	Lynn,	1	-	1
Easton,	1	-	1	Lynnfield,	2	-	2
Essex,	3	1	2	Malden,	4	3	1
Everett,	102	30	72	Manchester,	4	-	4
Fall River,	2	1	1	Mansfield,	27	11	16
Falmouth,	4	1	3	Marblehead,	1	1	-
Foxborough,	24	3	21	Marion,	2	-	2
Framingham,	17	4	13	Marlborough,	24	5	19
Franklin,	5	3	2	Marshfield,	1	1	-
Freetown,	1	1	-	Mashpee,	1	1	-
Gardner,	1	-	1	Mattapoisett,	1	1	-
Gill,	2	1	1	Maynard,	32	12	20
Gloucester,	59	20	39	Medfield,	5	1	4
Granby,	1	1	-	Medford,	65	13	52
Great Barrington,	12	3	9	Medway,	1	1	-
Greenfield,	1	-	1	Melrose,	45	7	38
Groveland,	1	-	1	Merrimac,	4	1	3
Hamilton,	1	-	1	Methuen,	5	2	3
Hanover,	5	-	5	Middleborough,	5	2	3
Hanson,	3	-	3	Middleton,	3	1	2
Harwich,	4	3	1	Milford,	49	20	29
Haverhill,	1	-	1	Millis,	1	1	-
Hingham,	5	1	4	Milton,	6	2	4
Holbrook,	3	-	3	Nantucket,	1	-	1
Holden,	2	1	1	Natick,	16	4	12
Holliston,	2	-	2	Needham,	19	7	12
Hopedale,	2	-	2	New Bedford,	2	-	2
Hopkinton,	3	2	1	Newburyport,	3	-	3
Hudson,	10	3	7	Newton,	5	-	5
Hull,	4	1	3	Norfolk,	1	1	-

CITY OR TOWN.	Whole Number of Examinations.	Positive.	Negative.
North Adams,	5	2	3
North Andover,	1	-	1
North Attleborough,	38	10	28
North Brookfield,	5	3	2
North Reading,	1	-	1
Northfield,	9	2	7
Norton,	6	2	4
Norwell,	4	-	4
Norwood,	20	6	14
Oxford,	2	2	-
Peabody,	36	11	25
Pembroke,	1	-	1
Petersham,	2	-	2
Pittsfield,	39	19	20
Plainville,	4	-	4
Plymouth,	8	4	4
Plympton,	1	-	1
Provincetown,	1	-	1
Quincy,	96	31	65
Randolph,	8	3	5
Reading,	23	2	21
Rehoboth,	1	-	1
Revere,	35	14	21
Rockland,	28	5	23
Rockport,	20	4	16
Russell,	1	-	1
Salem,	104	30	74
Sandwich,	5	1	4
Saugus,	38	8	30
Scituate,	3	1	2
Sheffield,	1	-	1
Shelburne,	12	1	11
Sherborn,	13	6	7
Shirley,	2	-	2
Somerville,	3	1	2
South Hadley,	1	-	1
Spencer,	7	3	4
Stoneham,	8	2	6
Stoughton,	10	2	8
Taunton,	91	24	67
Templeton,	1	-	1
Townsend,	4	1	3
Upton,	4	1	3
Wakefield,	21	3	18
Walpole,	9	1	8
Ware,	6	4	2
Wareham,	8	1	7
Warren,	7	1	6
Watertown,	13	4	9
Wayland,	6	1	5
Wellfleet,	1	1	-
Wenham,	1	-	1
West Brookfield,	6	1	5
West Newbury,	2	1	1
Westborough,	2	-	2
Westfield,	12	6	6
Westford,	5	-	5
Westport,	3	2	1
Weymouth,	21	6	15
Whitman,	16	5	11
Williamstown,	5	2	3
Wilmington,	1	-	1
Winchendon,	5	2	3
Winchester,	39	12	27
Winthrop,	3	-	3
Woburn,	26	10	16
Yarmouth,	2	-	2
Totals,	2,383	785	1,598

TYPHOID FEVER.

WIDAL, AGGLUTINATIVE OR SERUM TEST.

During the year ended Nov. 30, 1911, the Widal test was carried out with 1,015 specimens of blood. Of these specimens, 253, or 24.9 per cent., gave a positive reaction. Specimens were sent from 126 cities and towns. These facts are shown in detail in Table I. In a second table (Table II.) the specimens, positive and negative, are classified according to the day of the disease on which they were collected. A moderate number of second and third specimens from the same case were examined, so that the total number of tests made is somewhat over the number of cases of disease concerned. The methods used during the year were the same as those previously in use in the laboratory, and they have been amply described in the reports of the year 1900 and the years following.

TABLE I. — *Widal Test, Dec. 1, 1910, to Nov. 30, 1911, inclusive, classified according to the City or Town from which the Specimen was sent.*

CITY OR TOWN.	Whole Number of Examinations.	Positive.	Negative.
Abington,	8	1	7
Acton,	2	1	1
Adams,	2	1	1
Amesbury,	2	-	2
Amherst,	2	2	-
Andover,	1	-	1
Arlington,	10	3	7
Attleborough,	81	28	53
Ayer,	3	1	2
Barnstable,	3	-	3
Bedford,	3	2	1
Belmont,	4	-	4
Beverly,	14	3	11
Billerica,	3	-	3
Blackstone,	5	2	3
Boston,	3	-	3
Bourne,	2	-	2
Braintree,	9	3	6
Bridgewater,	3	1	2
Burlington,	2	-	2
Cambridge,	1	-	1
Canton,	5	2	3
Carlisle,	1	1	-
Chelsea,	56	20	36
Chesterfield,	1	-	1
Cohasset,	21	3	18
Concord,	1	-	1
Dalton,	1	-	1

TABLE I. — *Widal Test, etc.* — Continued.

City or Town.	Whole Number of Examinations.	Positive.	Negativo.	City or Town.	Whole Number of Examinations.	Positive.	Negative.
Danvers,	4	1	3	Middleborough,	1	-	1
Dartmouth,	1	1	-	Middleton,	2	-	2
Dedham,	14	-	14	Milford,	15	5	10
Dennis,	3	-	3	Millis,	1	-	1
East Bridgewater,	5	2	3	Milton,	10	2	8
Easthampton,	1	-	1	Monson,	1	1	-
Everett,	26	3	23	Nantucket,	2	-	2
Falmouth,	5	2	3	Natick,	34	12	22
Fitchburg,	1	-	1	Needham,	10	-	10
Foxborough,	1	-	1	New Marlborough,	1	-	1
Gloucester,	22	2	20	Newburyport,	1	-	1
Hamilton,	1	-	1	Newton,	44	11	33
Hanover,	1	-	1	North Adams,	7	1	6
Hanson,	1	1	-	North Attleborough,	15	7	8
Harvard,	1	-	1	North Brookfield,	11	2	9
Harwich,	4	1	3	North Reading,	3	1	2
Hingham,	2	-	2	Northampton,	15	3	12
Holbrook,	1	-	1	Northfield,	1	1	-
Holden,	10	6	4	Norwood,	10	3	7
Holliston,	1	-	1	Palmer,	2	1	1
Hopedale,	1	-	1	Pittsfield,	3	-	3
Hopkinton,	2	-	2	Plymouth,	1	-	1
Hull,	12	-	12	Quincy,	27	6	21
Lawrence,	1	-	1	Randolph,	3	1	2
Lexington,	12	3	9	Reading,	4	2	2
Lincoln,	3	-	3	Rehoboth,	1	1	-
Lynn,	97	26	71	Revere,	12	3	9
Malden,	3	-	3	Rockland,	3	-	3
Marlborough,	14	5	9	Rockport,	4	2	2
Maynard,	7	-	7	Russell,	3	3	-
Medford,	17	2	15	Salem,	5	2	3
Medway,	1	-	1	Salisbury,	1	-	1
Melrose,	19	3	16	Sandwich,	1	-	1
Methuen,	1	1	-	Saugus,	13	3	10

TABLE I. — *Widal Test, etc.* — Concluded.

CITY OR TOWN.	Whole Number of Examinations.	Positive.	Negative.	CITY OR TOWN.	Whole Number of Examinations.	Positive.	Negative.
Scituate,	3	1	2	Wayland,	9	1	8
Shelburne,	1	-	1	Wellesley,	2	1	1
Sherborn,	1	-	1	West Bridgewater,	1	-	1
Somerville,	8	3	5	West Tisbury,	1	-	1
Stoneham,	4	-	4	Westfield,	8	5	3
Stoughton,	1	-	1	Westwood,	2	-	2
Swampscott,	4	1	3	Weymouth,	9	1	8
Taunton,	30	9	21	Wilbraham,	10	8	2
Tisbury,	1	1	-	Williamsburg,	2	-	2
Upton,	1	-	1	Wilmington,	2	-	2
Wakefield,	12	1	11	Winchendon,	4	-	4
Wales,	1	-	1	Winchester,	7	-	7
Walpole,	2	1	1	Winthrop,	20	7	13
Wareham,	2	1	1	Woburn,	49	6	43
Warren,	1	-	1	Totals,	1,015	253	762
Watertown,	6	-	6				

TABLE II. — *Widal Test, according to Stage of Disease, Dec. 1, 1910, to Nov. 30, 1911, inclusive.*

APPROXIMATE NUMBER OF DAYS FROM BEGINNING OF DISEASE TO COLLECTION OF BLOOD.	NUMBER OF CASES.		APPROXIMATE NUMBER OF DAYS FROM BEGINNING OF DISEASE TO COLLECTION OF BLOOD.	NUMBER OF CASES.	
	Positive.	Negative.		Positive.	Negative.
1,	1	7	11,	20	34
2,	2	16	12,	10	23
3,	6	25	13,	10	20
4,	7	33	14,	13	53
5,	5	34	15,	8	15
6,	20	60	16,	10	12
7,	23	64	17,	6	3
8,	18	54	18,	4	10
9,	16	39	19,	3	17
10,	19	29	20,	-	6

TABLE II. — *Widal Test, etc.* — Concluded.

APPROXIMATE NUMBER OF DAYS FROM BEGINNING OF DISEASE TO COLLECTION OF BLOOD.	NUMBER OF CASES.	
	Positive.	Negative.
21,	5	17
22,	3	1
23,	-	6
24,	1	2
25,	2	6
26,	-	2
27,	1	4
28,	1	6
29,	2	1
30,	1	3
31,	-	1
33,	-	3
34,	-	1
35,	-	2
36,	-	1
38,	-	1
39,	-	1
41,	-	1
43,	-	1
49,	-	3
51,	3	-
55,	-	1
62,	-	1
63,	-	1
64,	1	-
65,	-	1
Not stated,	32	141
Totals,	253	762

MALARIA.

From Dec. 1, 1910, to Nov. 30, 1911, 51 blood specimens were received, to be examined for the presence or absence of malaria parasites. The percentage of positive cases was 17.6.

The following table shows the city or town from which the specimens, positive and negative, were derived: —

City or Town.	Whole Number of Examinations.	Positive.	Negative.	City or Town.	Whole Number of Examinations.	Positive.	Negative.
Bourne,	1	1	-	North Attleborough,	1	-	1
Braintree,	1	-	1	Norwood,	8	1	7
Dedham,	5	2	3	Saugus,	2	-	2
Hull,	4	1	3	Sherborn,	2	-	2
Lynn,	2	-	2	Walpole,	2	-	2
Melrose,	7	1	6	Winthrop,	3	2	1
Natick,	10	1	9	Woburn,	1	-	1
Newton,	2	-	2	Totals,	51	9	42

REPORT UPON INVESTIGATIONS
OF
LOCAL OUTBREAKS OF INFECTIVE DISEASES.

REPORT UPON INVESTIGATIONS OF LOCAL OUTBREAKS OF INFECTIVE DISEASES.

Other accounts of outbreaks of infective diseases which have been investigated by State Inspectors of Health are recorded in another portion of the annual report under the heading "Fifth Annual Report on the Work of the State Inspectors of Health."

AN EPIDEMIC OF TONSILLITIS DUE TO INFECTED MILK.[1]

On Sunday, May 14, 1911, I received in the evening a telephone message from Dr. E. A. Darling of Cambridge, stating that tonsillitis was unusually prevalent in the city of Cambridge, and that it seemed to have an intimate relation to the Deerfoot milk supply. The matter was referred immediately for investigation to Dr. W. W. Walcott, State Inspector of Health for District No. 10, in which Southborough, the home of Deerfoot milk, is situated, and also to Dr. Frank L. Morse of Somerville, State Inspector of Health for District No. 5, in which district lies the city of Cambridge.

The preliminary reports concerning the situation began to come into the office of the State Board of Health within a few days, and were very conflicting. Dr. Walcott stated that in his district no relation to the Deerfoot farm milk could be made out, whereas in Dr. Morse's district such a relation was apparently very marked. For instance, in the city of Marlborough an investigation of 57 cases of tonsillitis taken at random showed that Deerfoot milk constituted about 50 per cent. of the city's supply, and was used either alone or combined with other milk supplies in 47 per cent. of the cases, and that the other 9 milk dealers were implicated in proportions that would naturally be expected from the amount of milk supplied by them. In Cambridge, on the other hand, of a total of 223 cases, it was found that, with but 5 exceptions, all of them had obtained milk from the Deerfoot farm supply. The greater number of cases appeared to occur on the 13th, 14th and 15th of the month, after which time there was a steady diminution. At an early stage of the investigation it was rumored, moreover, that tonsillitis was epidemic in other cities of the Commonwealth, and also in more distant cities, such as New York, New Haven and Washington. In fact, it was thought that in connection with the cases of tonsillitis in Southborough a source of infection had been found in a party of tourists who, some two weeks previously, had visited Washington, where the disease was said to be prevalent. Letters of inquiry, however, sent to all the State Inspectors of Health in Massachusetts, and also to the above-mentioned cities and other States, soon showed that the rumors as to prevalence of tonsillitis in those cities were unfounded. The necessity for seeking the source of this epidemic near home became more and more apparent.

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[1] By Mark W. Richardson, M.D., Secretary of Massachusetts State Board of Health. Reprinted from the Boston Medical and Surgical Journal, Dec. 14, 1911.

Fortunately, the town of Brookline planned almost immediately a house-to-house investigation of the disease, but the preliminary reports from this investigation also discredited quite emphatically the idea that the disease was due to any special milk supply. It was with great interest, however, that the final figures secured by this board were awaited. Through the kindness of Dr. Frederick H. Osgood, milk inspector of the Brookline board of health, I was enabled some weeks later to examine the figures obtained by this board and also a map on which had been plotted the milk supply of the town, together with the cases of tonsillitis which had occurred in the town during the epidemic period. I regret very much that this map could not be reproduced and presented at this meeting, for I believe that, even though such a map must be only approximately accurate, the information to be derived from it has been of great value.

The figures obtained in Brookline have been reproduced in chart form by Dr. Harry Linenthal, State Inspector of Health for District No. 4, and this chart shows to my mind that the occurrence of tonsillitis in Brookline must have been due to contamination of the Deerfoot farm milk supply.

The chart shows the relation of the number of cases of tonsillitis which occurred in 3,445 houses in Brookline as compared with the number of houses supplied by each of the various milk contractors, and you see that, whereas Deerfoot farm supplied only 13.8 per cent. of the total number of houses, 61 per cent. of the total cases investigated occurred in houses supplied with Deerfoot milk.

Another interesting feature brought out by the map of Dr. Osgood was that a certain portion of the town, although quite fully supplied with Deerfoot milk, showed practically no cases of tonsillitis. This fact, difficult to explain at first, has been made perfectly clear by the statement that the unaffected portion of Brookline received its milk from the so-called Northborough supply, whereas the infected areas received their milk from the so-called Southborough portion of the Deerfoot supply.

Five cultures taken from infected individuals have been subjected to

MILK DEALERS

1 ALDEN
2 BARRY
3 BERRY,
4 BERRY,
5 BEZANS
6 BLODGE
7 BOND
8 BRADBU
9 BRADLE
10 BRIGHA
11 CABOT
12 CEDARC
13 CHAPIN
14 CHERRY
15 CHILDS
16 CUSICK
17 DEERFO
18 ENGLISH
19 FOX HIL
20 HICKEY
21 HOOD
22 HYLAND
23 KINCARE
24 KINGSTO
25 LALLY
26 M^c^GRAIL
27 MISKELL
28 O'KANE
29 SMITH
30 STEARNS
31 SHAW
32 WALKER-G
33 WANWINE
34 WHITING,
35 WHITING,
36 WHITNEY
37 UNKNOW
38 PRIVATE C
39 CONDENS
40 NON USE

MICH

investigation by Prof. Theobald Smith, pathologist to the State Board of Health. One of these cultures differed from the other four and soon died out. It was probably one of the *pneumococci*. The remaining four represented cases of empyema, erysipelas and adenitis, and a fatal case concerning which further information is not available. These cultures were all *streptococci* growing fairly well in ordinary agar and in bouillion without blood or other similar additions. In bouillion the *cocci* all appeared in fairly long chains. They were all hæmolytic in blood agar. Virulence tests are in progress. These cultures thus correspond to *streptococcus pyogenes*, and there have been no individual differences discernible thus far.

Their source may perhaps be determined by comparative tests which include *streptococci* from human, bovine and equine disease.

ANTERIOR POLIOMYELITIS.

Investigations concerning anterior paralysis, published [in 1912] in a special pamphlet, as mentioned on page 44, included the following subjects: —

"The Occurrence of Infantile Paralysis in Massachusetts in 1910," reported for the Massachusetts State Board of Health by Robert W. Lovett, M.D., Boston, and Philip A. E. Sheppard, M.D., Boston.

"Anterior Poliomyelitis. — Attempts to transmit the Disease to Monkeys by Inoculation with the Nasal, Pharyngeal and Buccal Secretions of Eighteen Human Cases," by M. J. Rosenau, M.D., Professor of Preventive Medicine and Hygiene, Harvard Medical School, Boston; Philip A. E. Sheppard, M.D., Special Investigator for the Massachusetts State Board of Health, Boston; and Harold L. Amoss, M.D., Assistant in Preventive Medicine and Hygiene, Harvard Medical School, Boston.

"An Investigation as to the Occurrence in Massachusetts of Paralysis in the Lower Animals and Fowls," by Arthur W. May, D.V.M., Boston, Mass.

"An Investigation concerning Infantile Paralysis as it occurred in the City of Fall River in 1910," by Dr. Thomas P. Hennelly, Waltham, Mass.

"Infantile Paralysis with Especial Reference to its Occurrence in Massachusetts, 1907–1910," by Robert W. Lovett, M.D., of Boston, and Mark W. Richardson, M.D., of Boston.

"A Study of an Epidemic of Infantile Paralysis (Acute Epidemic Poliomyelitis) in Springfield, Mass., in 1910," by Philip A. E. Sheppard, M.D., Boston.

"The Possible Etiological Relation of Certain Biting Insects to the Spread of Acute Epidemic Poliomyelitis," by Charles T. Brues, Instructor in Economic Entomology, Harvard University, and Philip A. E. Sheppard, M.D., Boston, Mass.

"An Investigation of the Blood in Cases of Acute Epidemic Poliomyelitis (Infantile Paralysis)," by J. W. Hammond, Jr., A.B. (Fourth Year Student, Harvard Medical School), and Philip A. E. Sheppard, M.D., of Boston.

"Experiments as to the Protective Value of Certain Specific Sera and Vaccines against the Virus of Poliomyelitis," by William P. Lucas, M.D., Boston, and Robert B. Osgood, M.D., Boston.

"Prognosis in Infantile Paralysis," by B. E. Wood, M.D., Boston, Mass.

FIFTH ANNUAL REPORT

ON THE

WORK OF THE STATE INSPECTORS OF HEALTH.

BY THE ASSISTANT TO THE SECRETARY OF THE BOARD.

FIFTH ANNUAL REPORT ON THE WORK OF THE STATE INSPECTORS OF HEALTH.

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POWERS AND DUTIES OF THE STATE INSPECTORS OF HEALTH.

PART I. — ADVISORY AUTHORITY.

I. — Diseases Dangerous to the Public Health.[1]

The State Inspectors of Health deal with diseases dangerous to the public health by —

1. Gathering information concerning —
   (*a*) All influences that are or may be dangerous to the public health.
   (*b*) The prevalence of tuberculosis and other communicable diseases.
2. Disseminating knowledge as to the best methods of preventing the spread of communicable diseases.
3. Taking such steps as, after consulting with the State Board of Health and the local health authorities, are deemed advisable for the eradication of all diseases dangerous to the public health.
4. Aiding the State Board of Health in the enforcement of the laws relating to the maintenance of isolation hospitals, tuberculosis hospitals and wards by cities and towns, and to the maintenance of tuberculosis dispensaries by cities and towns of 10,000 inhabitants or over.
5. Assisting the State Board of Health in the enforcement of the laws relative to the furnishing of drinking water on passenger trains.

II. — Health Inspection in Factories.[2]

The State Inspectors of Health study the health of persons employed in factories and workshops by —

1. Gathering information concerning —
   (*a*) The prevalence of tuberculosis and other communicable diseases in factories and workshops.

   Community health is, in a measure, dependent upon the health of persons employed in factories and upon the prevalence of disease in such establishments. The health of persons working in factories is, in turn, to a considerable extent dependent upon conditions in these buildings. In the absence of a law providing for the physical examination of adults in factories, the State Inspectors of Health, as a regular procedure at the present time, confine such examinations to minors. In the interest of public health, however, they inform employers and employees in certain instances of the desirability of making examinations of adults for the detection of tuberculosis or other communicable diseases.

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[1] Anterior poliomyelitis, actinomycosis, Asiatic cholera, cerebro-spinal meningitis, diphtheria, glanders, leprosy, malignant pustule, measles, ophthalmia neonatorum, scarlet fever, smallpox, tetanus, trachoma, trichinosis, tuberculosis, typhoid fever, typhus fever, varicella, whooping cough and yellow fever.

[2] Acts of 1907, chapter 537; Acts of 1910, chapters 404 and 543; Acts of 1911, chapter 603.

(*b*) The ill health or physical unfitness of minors.

The work of obtaining information concerning the health of minors employed in factories calls for: (1) A knowledge by the State Inspectors of Health of the ill health or physical unfitness of the minors, and involves (2) Obtaining personal and family histories, recording observations, and, in a considerable proportion of cases, making physical examinations.

2. Investigating the effects of occupation on health by considering —

(*a*) The existence of occupational diseases in industrial establishments.

Without some knowledge of community life and conditions it is impossible to understand and weigh accurately the probable effects of occupation on health and their bearing upon the public health.

(*b*) The existence of any occupation, process of manufacture or method which is injurious to the health of adults. In the absence of a law providing for the physical examination of adult workers in factories, State Inspectors of Health inform employers and employees in certain instances of the desirability of making examinations for the detection of lead, mercury or other types of industrial poisoning.

3. Investigating the employment of minors in occupations, processes of manufacture or methods that are injurious to health.

The inquiries do not include those occupations which give rise to or cause physical injuries, or are dangerous to life or limb.

4. Investigating the lighting of factories and workshops for the purpose of protecting the eyesight of the workers.

This inquiry relative to the lighting of factories and workshops in relation to the eye and vision includes the consideration of light in connection with —

(*a*) The kind of work done.

(*b*) The acuteness of vision, and the degree of attention required by the work.

(*c*) The kind, amount and distribution of light.

(*d*) The frequency with which glasses are worn by the employees.

(*e*) The types, frequency and extent of injuries to the eyes of the employees in certain occupations and processes, and whether

(*f*) Any danger of injury to the eyes that is discovered may be decreased or prevented by any mechanical device or practicable means.

5. Investigating the effect on health of indoor dampness and excessive heat in factories and workshops.

This inquiry relates particularly to the regulation of the humidity and temperature in textile factories. Its purpose is to lead to the adoption of such regulations as are practicable to prevent any unnecessary exposure of employees to indoor dampness and extremes of heat.

III. — Protection of the Health of School Children.[1]

The State Inspectors of Health endeavor to protect the health of school children by —

1. Making such examinations of school buildings as in the opinion of the State Board of Health the protection of the health of the pupils may require.
2. Bringing into co-operation school physicians in the effort to guard against ill-ventilated or overcrowded schoolrooms.

IV. — Investigation of Water Supplies and Sewerage Systems.[2]

The State Inspectors of Health aid the water and sewerage department of the State Board of Health.

V. — Co-operation with Local Boards of Health.[2]

The State Inspectors of Health co-operate with local boards of health by —

1. Giving assistance and information in regard to —
   - (*a*) Drafting rules and regulations relating to the public health.

     Uniformity in health work throughout the Commonwealth, and in consequence the provision of better conditions under which people live is expected to result from such assistance.
   - (*b*) Methods of preventing the spread of diseases dangerous to the public health.
   - (*c*) The manner of caring for persons found ill in a neglected condition with a disease dangerous to the public health.
   - (*d*) The enforcement of quarantine.
   - (*e*) The sanitation of tenement houses.

     A high standard of sanitation in factories brought about largely by rigid inspection should go hand in hand with improved home conditions, particularly the tenement homes.
   - (*f*) The make-up of a proper first-aid outfit for factories and workshops.

     As the result of an inquiry by the State Inspectors of Health in regard to the requirements of local health authorities in accordance with the act relative to keeping medical and surgical appliances in factories and shops, it was found that as a rule too many articles were required; essentials were often omitted and in their place were put articles which should not properly be included in a first-aid outfit.

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[1] Acts of 1909, chapter 514, section 105.

[2] Acts of 1907, chapter 537.

In order to insure more uniformity of action on the part of the local health authorities and to prevent further misunderstanding of the law and the consequent lessening of its value, the State Inspectors of Health recommend a list of articles for requirement by the local health authorities which is simple and practical, containing only essentials. Whenever it appears to a State Inspector of Health that a proper first-aid outfit is not provided in a factory or shop, he notifies the local board of health of the city or town in which the establishment is located.

(*g*) The provision for receptacles for expectoration in factories and workshops.

The law provides that proprietors of all factories and workshops shall provide receptacles for expectoration, and that the local boards of health shall approve the form, construction and number of such receptacles. Whenever the State Inspectors of Health deem it advisable or necessary they (1) consult with the local boards of health relative to the form, construction and number of receptacles which should be approved for the different kinds of factories and industries, and (2) notify the local board of health of the city or town in which an establishment is located wherein such receptacles for expectoration are not provided.

(*h*) The recording of statistics relating to health work of all kinds.

The State Inspectors of Health assist the Massachusetts Association of Boards of Health through its committee appointed to consider the question of uniform health reports to secure uniformity in gathering and reporting statistics.

2. Investigating and reporting —

(*a*) Any known cases of ophthalmia neonatorum.

In order that the law requiring local boards of health "to take such immediate action as they may deem necessary in order that blindness may be prevented" may be enforced, the State Inspectors of Health investigate and report to the local boards of health all known cases of infants having inflamed, swollen and red eyes with an unnatural discharge.

(*b*) Every disease dangerous to the public health discovered in a tenement workshop.

(*c*) The existence of any disease dangerous to the public health in factories, workshops or other industrial establishments.

(*d*) All outbreaks and epidemics of communicable diseases.

(*e*) The existence of local nuisances.

By nuisances is meant public nuisances, that is, objectionable conditions which affect the public or the community. In determining the existence of a nuisance, health, comfort, convenience and interest of the community are factors for consideration. In the matter of preventing, destroying, or mitigating nuisances which endanger health the local boards of health have absolute authority. The function of the State Inspectors of Health is to investigate such nuisances if necessary for the purpose of bringing them to the attention of the local authorities and of recommending measures for the removal of objectionable conditions. Copies of written suggestions to local health authorities in every instance are sent to the State Board of Health.

PART II. — EXECUTIVE AUTHORITY.

I. — Health Inspection in Factories.

The State Inspectors of Health inspect factories primarily for the purpose of protecting the health and welfare of the persons employed therein. The factory, however, is not an isolated part of the community. In manufacturing centers factory employees mingle freely with persons in other walks of life. The health of the persons who work in factories, therefore, may affect materially the health of the public.

Unlike the consideration of such matters as the means of egress in case of fire, — a sort of inspection work complete in itself, — the study of the sanitation of factories and its effect upon health is not limited by the factory walls, but involves a knowledge of the sanitation of each industrial community, including the factory and the home; it includes —

(*a*) In the factory not merely the inspection of the building, but some knowledge of each industrial process and a study of the probable effects of occupation upon the health of the workers at their work, as well as the investigation of the prevalence of communicable and occupational diseases.

(*b*) In the home, some knowledge of the sanitation of home life and surroundings, the habits of the workers and the prevalence of disease.

In other words, the kind of inspection done by the State Inspectors of Health in factories is health inspection rather than factory inspection. The latter signifies work that is confined within the walls of a factory. Health inspection, on the other hand, means the investigation of all influences dangerous to the public health or threatening to affect the same within or without the factory, the school and the home.

1. The enforcement of factory laws.

The work relative to the sanitation of factories, workshops and other industrial establishments includes the enforcement of certain laws —

(*a*) Relative to supplying pure drinking water for employees in manufacturing establishments (Acts of 1909, chapter 514, section 78).

(*b*) Relative to the purity and use of water for humidifying purposes in factories and workshops and to the regulation of humidity and temperature of the atmosphere in textile factories (Acts of 1908, chapter 325); (Acts of 1910, chapter 543).

(*c*) Relative to the lighting, ventilation and cleanliness of factories and workshops (Acts of 1909, chapter 514, section 94).

(*d*) Relative to providing mechanical ventilating apparatus in factories and workshops (Acts of 1909, chapter 514, sections 83–85 inclusive).

(*e*) Relative to providing emery wheels and belts and buffing wheels and belts with hoods, suction pipes and fans or blowers for the protection of employees against dust (Acts of 1909, chapter 514, sections 86–90, inclusive).

(*f*) Relative to providing seats for women employees (Acts of 1909, chapter 514, section 72).

(*g*) Relative to providing foundries with adequate washing facilities and water-closets and to the connection of such buildings with a public sewerage system (Acts of 1909, chapter 514, section 102; R. L., chapter 49, section 30).

(*h*) Relative to providing proper water-closets for both sexes (Acts of 1909, chapter 514, sections 79–82 inclusive, as amended by chapter 259, Acts of 1910).

(*i*) Relative to prohibiting the use of suction shuttles in factories (Acts of 1911, chapter 281).

2. The exclusion of minors from occupations injurious to health (Acts of 1910, chapter 404).

The law relating to the exclusion of minors from occupations injurious to their health may be made applicable to —

(*a*) A single establishment.
(*b*) A department in an establishment, or
(*c*) A single minor.

From an educational point of view it has great value.

It insures fair treatment to both the employer and the minor.

The law is not applicable to any factory wherein such special measures are adopted as appear to the State Inspector of Health to be reasonably practicable and meet the necessities of the case.

3. The provision for devices for preventing eye injuries (Acts of 1911, chapter 603).

The law providing for an investigation of proper lighting conditions of factories and workshops for the purpose of protecting the eyesight of the employees also provides for protection against injury to the eyes by mechanical devices or other practicable means ordered by a State Inspector of Health with the approval of the State Board of Health.

II. — Inspection of Tenements where Clothing is made.[1]

The primary object of the inspection of tenements where clothing is made, by the State Inspectors of Health, is to guard the public health against the spread of contagious diseases by means of infected wearing apparel. The work accomplished has resulted in the maintenance of higher sanitary standards in the congested tenement homes. The friendly visits to the homes and the close personal contact with the workers have been a great educational force in the development of higher standards of hygienic living.

III. — Inspection of Mercantile Establishments.[2]

The State Inspectors of Health inspect mercantile establishments —

1. To determine whether a sufficient number of seats are provided for women employees and whether there are proper toilet rooms for both sexes in such establishments, and
2. To enforce the statute provisions relating thereto.

IV. — Inspection of Police Station Houses, Lockups, Houses of Detention, Jails, Houses of Correction, Prisons and Reformatories.[3]

In accordance with the laws providing for the examination of the sanitary conditions in police station houses, lockups, houses of detention, jails, houses of correction, prisons and reformatories, the State Inspectors of Health consider —

1. Ventilation.
2. Heating.
3. Lighting.
4. Construction of cells.
5. Care and use of bedding and dishes used for food.
6. Method of sewage disposal, and
7. Method of supplying drinking water to prisoners.

V. — Inspection of Slaughterhouses.[4]

In addition to local supervision all slaughterhouses are —

1. Under the supervision of the State Board of Health and
2. Subject to the inspection by the State Inspectors of Health in their respective districts.

DISEASES DANGEROUS TO THE PUBLIC HEALTH.

Of the many duties imposed by the Legislature upon the State Inspectors of Health, none are of greater importance or more far-reaching in their effects upon the conservation of the health of the inhabitants than is the requirement that the State Inspectors of Health inform themselves concerning all influences that are or may be dangerous to the public health within their districts, and to gather all possible information relative to the prevalence of communicable diseases and to co-operate with the local health authorities in their eradication. Acting in an advisory capacity, the State Inspectors of Health have co-operated with the local boards of health throughout the State and have assisted them in various ways. Frequent conferences were held by the State Inspectors of Health with the local boards of health in the various districts. These conferences were often asked for by the local health officials who have come to rely on advice and guidance from the State Inspectors of Health in dealing with local health problems. In their dealing with local health problems the State Inspectors of Health had often to meet town officials, finance commissions, influential citizens, and physicians practicing in various communities. The range of subjects along which assistance was rendered to local boards of health covered almost every problem on health matters which is apt to come up in a community. To enumerate them briefly: —

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[1] Acts of 1909, chapter 514, sections 106–111 inclusive.

[2] Acts of 1909, chapter 514, sections 72, 79–82 inclusive, as amended by Acts of 1910, chapter 259.

[3] Acts of 1910, chapter 405, as amended by Acts of 1911, chapter 282.

[4] Acts of 1908, chapter 329, section 5.

Local boards of health who had no sanitary regulations were urged to draw up and have such regulations printed, and assistance was given to the various boards in formulating such regulations.

Many local boards were urged to have visiting nurses appointed to visit cases ill with communicable diseases and to see that proper isolation was maintained. In many instances the State Inspectors of Health came before the city or town officials or before finance commissions to urge a larger appropriation for the health work in the community so that such nurses might be appointed.

Local boards of health who had no milk inspectors were urged to appoint inspectors for that purpose, and in several communities such inspectors were appointed.

Advice was given to local boards of health relative to abatement of nuisances, to disposal of garbage, to inspection of meat slaughtered in neighboring States and not inspected by government inspectors.

Numerous conferences were held with local boards of health throughout the State relative to the control of diseases dangerous to public health, and advice was given as to methods of dealing with cases of tuberculosis, typhoid fever, ophthalmia neonatorum, scarlet fever, diphtheria, anterior poliomyelitis, cerebro-spinal meningitis and smallpox. In cases of smallpox local boards of health frequently asked the aid of the State Inspectors of Health in the diagnosis of the disease.

Local boards of health throughout the State have been notifying the State Inspectors of Health of the occurrence of diseases declared by the

State Board of Health to be dangerous to public health. Whenever it was practicable an investigation was made at once to determine if possible the source of the infection of early cases occurring in a community, especially in the absence of an active and efficient board of health, and to co-operate with the local board of health in checking the progress of the disease.

TUBERCULOSIS.

The work of the State Inspectors of Health in tuberculosis has been in general to inform themselves concerning the prevalence of the disease in their districts, to examine into those agencies having to do with the control of tuberculosis, to secure where possible an enforcement of the law relating to the reporting of cases of tuberculosis, and, through local health authorities and other agencies, to see to it that each case of tuberculosis coming within their knowledge received proper care and treatment. Special investigations concerning the tuberculosis problem within the Commonwealth were made and the foundation laid for the further examination and study of certain conditions related to this problem. Broadly, then, the work in tuberculosis may be divided into two groups: (*a*) that having to do with local health authorities and (*b*) that concerned in special investigation.

Work with Local Health Authorities.

An endeavor was made by several of the State Inspectors of Health to determine whether or not tuberculosis was being properly reported to local health authorities; an investigation of the causes for the unsatisfactory reporting of cases of the disease was made, and a report covering this subject and the possibility of the detection of unreported cases in time to be of service to the public was made to the State Board of Health. One State Inspector of Health, who made a careful inquiry into the subject, believed that many cases of tuberculosis were not recognized by physicians because of an insufficient examination of the patient, or an unwillingness to make a diagnosis of tuberculosis through fear of losing the patient, or because of sheer neglect.

When it was found that in any locality tuberculosis was not being reported, this fact was brought to the attention of the local health authority, specific instance of the neglect was given, and an endeavor was made to have the local health authority enforce the law. It was found that some boards of health made an effort to have cases reported, and that other boards were lax and gave this matter little or no attention.

In several instances, when it was found that through neglect persons ill with tuberculosis were not receiving suitable care or treatment, these facts were brought to the attention of the local health authorities, and the cases followed up and watched until proper measures had been taken for their relief. Illustrating such instances are these: —

1. An adult ill with tuberculosis and careless in his habits was found working in a large manufacturing establishment. This man discontinued his employment at the factory and received assistance from the local board of health.

2. A man ill with tuberculosis was found living in one room without means, nourishment, or proper clothing. Through the local board of health he was sent to a sanatorium.

3. A married man out of work and in destitute and miserable circumstances. The unsanitary condition of the home constituted a menace to the other members of the family. Through the local board of health this man was sent to a sanatorium.

4. A boy in the terminal stage of tuberculosis was found working in a restaurant and living in a home where miserable and unsanitary conditions prevailed. These facts were brought to the attention of individuals who interested themselves in the boy's behalf.

5. The condition of a young woman ill with tuberculosis and employed in a manufacturing establishment was brought to the attention of a charitable organization who furnished the funds for her return to her native country.

6. The attention of a local board was brought to the condition of an adult employed in a cotton mill. This man was in a far advanced stage of tuberculosis and lived in a crowded tenement. Through the local board of health he was placed in a sanatorium.

7. A male minor worked in a factory by day and in a bowling alley by night. He was an inveterate smoker. The owners of the factory where he worked provided funds for his stay in a sanatorium for thirteen weeks. Unfortunately he was discharged before the end of this period for breach of discipline.

8. A minor suspected of having tuberculosis was placed under observation in a tuberculosis clinic and was later admitted to the State sanatorium at Rutland.

Other and similar instances were given attention by the State Inspectors of Health. On one occasion, however, in which three cases of neglected tuberculosis were brought to the attention of the local board of health, this board refused to take action on the ground that they could not be expected to do so much work as they were paid nothing for their services.

Persons suspected of being ill with tuberculosis were examined at the requests of local boards of health.

Special Investigations.

An attempt was made to account for and devise a method of getting in touch with a class of minors as yet beyond the reach of the State Inspectors of Health, as they come between the school and the factory.

Attempts were also made to follow up and keep in touch with those patients discharged from State sanatoria and returning to residences within the State.

Inspections were made of institutions caring for tubercular patients, and in certain instances changes in the methods of these institutions were recommended.

Investigations as to the maintenance by cities of hospitals for tuberculosis were made, and in certain cities it was recommended that such hospital accommodations be provided.

Special investigations of the prevalence of tuberculosis among the workers in the jewelry and stone-cutting trades were begun, and the foundations laid for further study in this direction. Study was also made of the prevalence of the disease among certain alien races. Several of the inspectors gave talks upon tuberculosis in different cities and towns and in manufacturing establishments, while others, through their own initiative, caused funds to be raised for anti-tuberculosis work.

The methods of work among societies interested in the control of tuberculosis were studied and in certain districts a careful and complete study was made of the work of each city and town in preventing the spread of tuberculosis.

An inquiry was instituted and report made as to the custom of various health boards in the matter of cleansing and disinfecting houses after the removal by death or otherwise of cases of tuberculosis. This inquiry showed many communities in which no effort was made by the health authorities to cleanse or disinfect such premises.

TYPHOID FEVER.

An investigation was made of a case of typhoid fever which occurred in a young man who worked on a dairy farm in Agawam. From this dairy milk was delivered in Springfield. The patient was removed to his home, and the boards of health, both of Springfield and Agawam, were notified. Suggestions were also made as to precautions to be taken in case the young man returned to work on the farm.

Fourteen cases of typhoid fever occurring in Chicopee and Chicopee Falls were investigated. The cases were not confined to any one milk supply. Six of the cases were men employed in one factory. An analysis of the water supply by the State Board of Health showed it to be badly polluted. Another case was that of a young man employed as a core-maker in a foundry who was in the habit of drinking water from a shallow well open to pollution. Both these water supplies were shut off and the city water was supplied. Two of the cases were in the family of a man who had a little candy store. Upon recommendation of the State Inspector of Health, the local board of health prohibited the man from attending to his store while he was in contact with his children, ill with the disease.

An outbreak of 18 cases of typhoid fever occurring between June 30 and July 24, 1911, was investigated in Fitchburg; 12 of the cases were on one milk route. Nothing definite could be obtained on the farms from which this man got his supply; it was found, however, that one of the farms was very untidy, and that milk utensils were often washed in a brook polluted with sewage. The case of a man who had previously had typhoid fever was also found on this farm. Examination of his excreta proved negative. Soon after this milkman discontinued selling milk. No new cases occurred.

Three cases of typhoid were investigated in Hardwick. It was found that these cases resulted from contact with a mild, unrecognized case. Suggestions were made to the local health authorities in regard to proper isolation and proper disinfection of excreta in all the cases.

Ten cases of typhoid occurring in East Bridgewater were investigated. Although the source of the infection could not be found, it was highly probable that all of them contracted the disease at a church supper which they attended about two weeks previous to their being taken ill. The presence at this supper was the only factor common to all of them.

Six cases of typhoid were investigated in East Hardwick. The cases occurred almost simultaneously in different parts of the town. No common source of the infection could be determined. The local board of health was advised as to proper isolation and disinfection of excreta. No new cases occurred.

Four cases of typhoid were investigated in Maynard. It was found that two of the cases had been drinking milk given to them by a man who was found to be a typhoid carrier two years ago and who was at that time stopped from selling milk. He still keeps a cow for his own use, and during the absence of his wife from home he gave away his surplus milk.

Three cases of typhoid investigated in West Chelmsford were found to have used water from a polluted well. The use of the water was discontinued.

An outbreak of 19 cases of typhoid was investigated in Westfield.

The cases which occurred between July 21 and Sept. 14, 1911, were scattered throughout the town. Four of the cases were in the State sanatorium. Two of the cases were contracted out of town and several others were undoubtedly contact cases. There was no common milk, water or ice supply for all the cases. No history of contact could be obtained of the sanatorium cases with the other cases in the town. It was learned, however, that a man who was delivering vegetables throughout the town had been ill with typhoid fever for two weeks before he took to bed, and it is highly probable that the infected vegetables were the source of this outbreak.

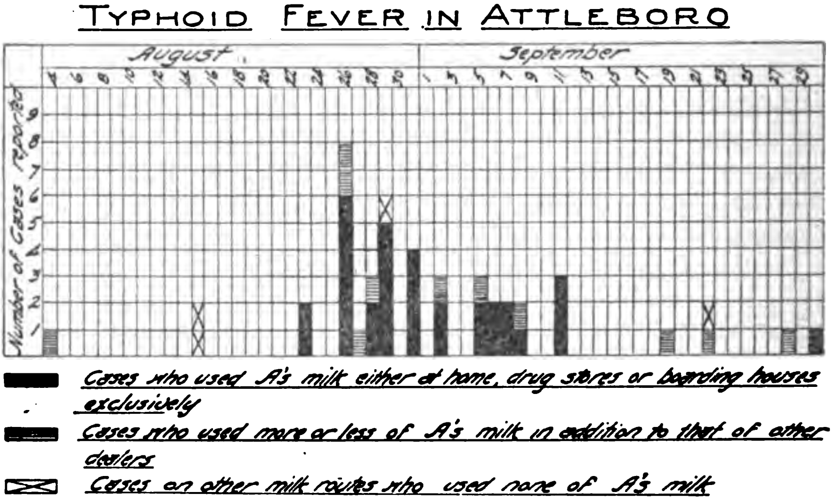
In certain sections of Pittsfield, North Adams and Clarksburg, where there is no public water supply and no sewerage system, cases of typhoid recur from year to year. This is particularly the case in West Pittsfield, where wells and springs, polluted, as shown by chemical analysis, serve as sources of water supply.

A somewhat similar condition is found in that part of Clarksburg immediately adjoining North Adams, on Houghton Street. The boundary line between these two communities is imaginary, and for the mutual protection of the two localities some plan should be devised whereby sewer and water facilities could be extended from North Adams, since the contour of the ground makes an independent system for that portion of Clarksburg impossible.

Report of an Outbreak of Typhoid Fever in Attleborough during August, 1911.

On Aug. 4, 1911, after several months of freedom from typhoid fever, a case of that disease occurred in Attleborough, followed on August 15 by 2 cases, on August 23 by 2 more and on August 26 by 8. While the height of the outbreak was reached on this date, 1 case of the disease occurred on the 27th, 3 on the 28th, 5 on the 29th, and 4 on the 31st of August. Gradually diminishing, the cases reported in September were: 3 on the 2d and 5th, 2 on the 6th, 7th and 8th, 3 on the 11th, and 1 on the 19th, 2 on the 22d, and 1 each on the 28th and 30th. In addition to these 46 cases which occurred during August and September, 1 person who was reported ill with the disease was found to have contracted it while out of town. Careful investigation showed that this case was in no way connected with the outbreak.

The sudden outbreak of cases occurring in a town for years practically free from the disease and for some months without a case, and the widespread distribution of the cases, pointed to a common source of infection and to the probability of a common milk supply as the source of infection. An investigation was made of the milk supply of the cases, therefore, by the State Inspector of Health of the district including Attleborough, Dr. Elliott Washburn, who found that all the patients but one, who was in Attleborough but two days and was ill when he arrived, obtained milk from one or more of 13 dealers. He found, further, that 31 patients used milk that was supplied only by dealer A., either in the home, boarding place or drug store. In this connection it is worthy of note that the clerk who dispensed milk shakes and other milk drinks in a drug store was himself stricken with the disease. Of the 15 patients so far unconsidered, 11 used milk from A.'s supply in addition to milk from the supply of other dealers. Of the remaining 4 cases, 1 patient used milk direct from dealer J., who supplied A. with milk; 3 patients used milk exclusively from other dealers. The diagnosis in one instance was found to be erroneous. The facts, therefore, showed that of the 46 persons who were stricken with typhoid fever during the months of August and September, 43 used milk which came directly or indirectly from one dealer's (A.'s) milk supply.



Investigation disclosed the fact that during the months of July and August dealer A. obtained his supply from 7 producers, who brought their milk to his station in Attleborough, where it was mixed and alleged to be pasteurized, then cooled and bottled. The empty cans were said to be washed, sterilized by steam, dried and returned to the producers. The work incident to these processes was done by A. and one assistant. A portion of the building was used as a wet-wash laundry, which opened by a large door directly into the room in which the bottling was done.

It was asserted that no laundry employee handled the milk in any way, and that the door connecting the rooms was usually closed. Neither dealer A. nor his assistant had recently been ill. Nor had there been recently a case of typhoid fever in the home of either. Moreover, neither had ever had the disease. The sanitary conditions at the milk station were worthy of commendation. On the other hand, while the examination of the premises of six of dealer A.'s producers disclosed unsanitary conditions in two instances, no presence of typhoid fever or other communicable disease could be discovered. At the home of the seventh producer, however, — producer J., of Rehoboth, — it was found that his daughter, Mrs. B., was ill in bed, and that she had been ill for more than four weeks, and that the attending physician, on August 4, obtained a positive Widal test. On consulting the physician, he stated that he notified the local board of health on August 4. According to the local board of health, however, no notice of Mrs. B.'s illness was received until the case was brought to their attention on August 26 by the State Inpector of Health. It was further discovered that producer J.'s household consisted of himself, his wife, Mrs. B., the patient, and a woman helper. According to the statement of producer J., the entire handling of the milk was done by himself, including the milking, washing the milking pails, and putting the milk into the cans. It appeared to the State Inspector of Health, however, that owing to the manner of the disposal of the patient's stools and the fact that there were ample opportunities for contact infection, the milk supply might easily have become infected. The explanation of the fact that a number of cases occurred later than the close of the usual incubation period for typhoid fever is probably due to the known delay on the part of physicians in reporting to the local board of health rather than to contact infection. The State Inspector of Health found, further, that the water used by producer J. for all milk purposes was supplied by a well about 25 feet deep, situated 50 feet from the premises and 25 feet from the spot of ground whereon sink waste material has been discharged for many years. An analysis made by the State Board of Health of a sample of the water from this well, taken on September 3, showed it to be badly polluted. The water had been used for washing the milk pails.

Thus it appears that there were two possible sources of infecting producer J.'s milk, which reached 43 of the 46 persons stricken, through (1) the case of typhoid fever in his own home, and (2) the badly polluted well water which was used for washing milk pails.

The practical conclusion concerning this outbreak is that a more careful supervision of the farms supplying milk for public sale is imperative. While, under the most efficient supervision, there will be milk-borne typhoid outbreaks which cannot be traced to any antecedent case on the farm because of persons who are unconscious carriers and disseminators of the typhoid bacillus, with suitable State supervision of milk production such outbreaks as this one might be prevented.

The ideal protection of milk supplies would include a thorough examination of every person who handles the milk in any way, as well as frequent examinations of the farm water supply and of the nearness of privy vaults to country wells.

Report of the Occurrence of Typhoid Fever in Hyde Park during the Year 1910.

During the year 1910, 91 cases of typhoid fever occurred in Hyde Park. This was an unusually large number of cases, as can be seen when compared with the incidence of the disease in the last period of five years, when the cases occurred as follows: —

	Cases.		Cases.
1906,	10	1909,	13
1907,	10	1910,	91
1908,	20		

The cases were reported to the local board of health as follows: —

	Cases.		Cases.
January,	1	July,	7
February,	5	August,	8
March,	4	September,	3
April,	2	October,	42
May,	2	November,	12
June,	3	December,	–

It can thus be seen that typhoid fever was prevalent throughout the year, with a slight increase in July and August, a marked increase in October, a diminution in November and a cessation in December. Whether all the cases reported to the local board of health were actually typhoid could not be definitely determined, as in many instances no Widal or other blood tests were made. The local board of health had records of 26 positive Widals and 4 negative. One case reported as typhoid was later determined to be a case of lead poisoning, and one a case of enterocolitis. On the other hand, during the investigation 4 cases of typhoid were found which had not been reported to the board of health. This makes a total of 91 cases. Sixty-six of the cases were males and 25 females.

The distribution according to the ages of the persons taken ill was as follows: —

	Cases.		Cases.
1 to 5,	6	36 to 40,	5
6 to 10,	10	41 to 45,	4
11 to 15,	15	46 to 50,	2
16 to 20,	20	51 to 55,	1
21 to 25,	12	56 to 60,	1
26 to 30,	7	Above 60,	1
31 to 35,	7		

The cases were generally spread throughout the towns and occurred with equal prevalence in the homes of the well-to-do as in the poorer quarters of the city. All classes of the community were affected, — laborers, artisans, professional men and school children.

Sources of the Infection.

Milk can be safely ruled out as being the source of the infection. The outbreak was of a slow, continuous infection and had not the explosive character characteristic of milk-borne epidemics. Moreover, the disease occurred on the routes of 18 different dealers obtaining their milk supplies from as many different sources.

Five of the cases reported were clearly contact cases occurring in the same house where the disease existed. There were also, in all probability, other contact cases in the Polish and Italian districts, where visiting the sick is a common practice.

Forty of the houses where the disease occurred were not connected with the sewer; in 13 of these there were water-closets in the houses draining into cesspools; in 27, privies in the yards were in use, many of which were in an uncleanly and offensive condition. The discharges from the typhoid patients were emptied into these privies.

Inquiries were made as to the methods in use of the disposal of the patients' stools. It was found that the methods of disinfection such as sprinkling sulpho-napthol or chloride of lime on the stool without thoroughly mixing it, and immediately depositing it in the privy, were inefficient.

There were thus scattered throughout the town a number of foci with exposed infectious material, and the danger of fly infection was great. In all probability a number of the cases contracted the disease in that manner, but the outbreak was by far too disseminated and prevalent in localities where the sanitary conditions were excellent, so that factors other than fly and contact must have been in operation.

There was nothing to indicate that ice, fruit or vegetables had any connection with this outbreak. The only factor common to all the cases was the town water, which on repeated examinations was found to be so polluted as to be unfit to drink.

On Oct. 15, 1910, the local board of health sent a circular to all householders urging that all water used for drinking purposes be boiled. On October 31 the water department commenced the use of hypochloride of lime, of which 6 pounds were added to each 1,000,000 gallons of water. The outbreak apparently then terminated.

Scarlet Fever.

Eight cases of scarlet fever were investigated in Andover. It was found that two children who were desquamating were attending school. This outbreak emphasized the need of regulations for the release from quarantine of persons ill with scarlet fever.

Twelve cases of scarlet fever were investigated in Partridgeville in the town of Athol. These cases occurred between April 13 and May 16, 1911. It appeared that the source of the infection was a mild, unrecognized case among the school children. Suggestions were offered to the local health authorities concerning the proper isolation and the quarantine of all patients ill with the disease.

Eight cases of scarlet fever were reported to the board of health of Chelsea during the first week in May. Investigation showed that all the cases were in the same neighborhood. One of the early cases was seen only once by a physician and no diagnosis was made. The child felt better in a day or two and was allowed to play with the other children in the neighborhood. Two weeks later the child was found desquamating and was promptly isolated by the board of health. All the other cases were in all probability the result of contact with this unrecognized case.

At the request of the Hampden board of health a case of scarlet fever was investigated in that town on April 1, 1911. The case was not properly isolated, and the father of the child, who was a farmer, delivered milk to Springfield. The boards of health of Hampden and Springfield were notified and the sale of milk from that farm was discontinued.

An outbreak of scarlet fever was investigated in Holyoke. Twelve of the cases occurred in August, 1911, 23 in September and 14 in October. The cases were distributed throughout the city, though nearly one-third of all the cases was in that section of the city called Elmwood. No suspicion pointed to the milk supply as the source of the infection. Many of the cases were very mild and were not recognized until late. These mild cases were in all probability the source of the spread of the disease.

The local board of health took active measures to stop the spread of the infection.

An outbreak of 11 cases of scarlet fever was investigated at Hull. All the cases but one were among school children, the other was a teacher. The source of this outbreak was probably a mild, unrecognized case among the school children. Active steps were taken by the local board of health to check the spread of the disease.

Two small outbreaks of scarlet fever were investigated in Leominster in December, 1910, and in April, 1911. There appeared to be no history of contact between any of the cases. Suitable precautions were taken by the local health authorities against the spread of the disease.

An outbreak of 31 cases of scarlet fever was investigated in Lowell. Twenty-five of the cases were traceable to a child who was attending school while desquamating. A strict quarantine was enforced and no new cases occurred.

A case of scarlet fever occurring in the family of a farmer in Montgomery was investigated on April 28, 1910. It was found that the father, who was in contact with the sick child, milked his cows and sent the cream to a Westfield dairy. The boards of health of Westfield and Montgomery were notified of the situation and the sale of milk and cream coming from this farm was stopped until the child was released from quarantine.

An unusually large number of cases of scarlet fever occurred in Quincy throughout the winter months. The State Inspector of Health co-operated with the local health authorities in an investigation of these cases. It was found that there were a large number of mild, unrecognized cases which caused the spread of the disease. The local board of health used every means within its power to control the spread of the disease, and adopted all the suggestions made by the State Inspector of Health.

An outbreak of 31 cases of scarlet fever in Westfield was investigated on July 26, 1911. It was found that the majority of the cases occurred in that district of the town occupied by Polanders. The outbreak originated in one Polish family where four children were ill with the disease. Their illness was so slight that no physician was called and no diagnosis was made. These children consequently were allowed to mingle with other children in the neighborhood causing many contact cases. Two of the cases occurred in the families of two farmers who supplied milk in the town. The farmers who were in constant touch with the children also milked the cows and handled the milk cans. A milkman who bought milk from one of these farmers, and who distributed it without mixing it with milk from other dairies, had eight cases of scarlet fever among the families where this milk was distributed. The matter was brought to the attention of the local board of health and the sale of milk was discontinued from this farm. Advice was also given to the board of health to remedy the unsanitary conditions which were found to exist in the district where the Polanders live.

DIPHTHERIA.

An investigation was made of diphtheria in Athol, where 16 cases occurred. The infections appeared to have been spread by a milkman who was found to have been ill with diphtheria several days before it was recognized. The disease spread either by contact of this milkman with his customers, or by infected milk bottles. Suggestions were made to the local board of health regarding the sterilization of all milk utensils, and the proper quarantine of patients ill with the disease.

A small outbreak consisting of 5 cases of diphtheria was investigated in Berlin. The source of the infection seemed to have been a mild, unrecognized case of diphtheria, which terminated fatally. Suggestions were offered to the local board of health regarding the taking of cultures from throats of all persons exposed to the disease. Twelve positive cultures were obtained from throats of persons who showed no clinical signs of the disease.

During the year diphtheria was prevalent to an unusual degree in Blackstone. Investigation showed that the causes of a large number of the cases were in all probability inadequate quarantine, discharge of patients before negative cultures were obtained, and possibly in some cases the delay in reporting cases to the local board of health. Suggestions were made to the local board of health that a more rigid quarantine be established and that a negative culture be taken before the quarantine was released.

An outbreak of 10 cases of diphtheria was investigated in Fitchburg. Three of these cases were among the nurses in a hospital, attending a child ill with diphtheria. In all the other cases contact with the hospital cases could be established. The hospital authorities acted promptly by closing the hospital temporarily to patients and visitors.

An investigation was made in Hardwick of the death of a child who had been ill with diphtheria. It was found that the case had not been properly isolated and that the undertaker, who was also the agent of the local board of health, had not taken the proper precautions in the burial of the child. The matter was brought to the attention of the board of health with recommendations that action be taken in the matter. The agent resigned.

An outbreak of diphtheria in Haverhill was investigated. Many of the cases were traced to contact with patients ill with the disease. It was apparent that the local board of health did not have facilities for supervising the isolation of cases ill with communicative diseases. An appeal was made to the municipal council for an extra appropriation for the employment of a visiting nurse.

During the month of December, 1910, an unusual number of cases of diphtheria occurred in the city of Melrose, for the most part among children attending the same room in the Whittier School. Investigations showed that the infection was due to a mild, unrecognized case of the disease in a child who attended this school. The patients ill with the disease were properly quarantined and cultures were taken from the throats of all the children in the same room. None of the cases were released from quarantine until negative cultures had been obtained.

A small outbreak of diphtheria was investigated in Newburyport, and advice was given to the local board of health as to measures to check the disease.

Two small outbreaks of diphtheria were investigated in Palmer, — one of 5 cases in December, 1910, and another of 8 cases in October, 1911. No common source of infection was discovered. The local board of health took all necessary precautions to prevent the further spread of the disease.

A small outbreak of diphtheria occurred in Pittsfield at the beginning of the school year. Fifty cultures were taken from the throats of the school children living in the vicinity where the cases occurred. Two of these cultures were positive and one was doubtful. Later, a child in the family from where the doubtful culture was obtained actually developed the disease. The children from whom the positive cultures were obtained were excluded from school and the outbreak was checked.

During the months of November and December, 1910, 23 cases of diphtheria were investigated in Springfield. With the exception of 3 cases all those ill with the disease lived under good sanitary conditions. In 6 of the cases histories of contact with children having the disease were obtained. Several conditions of interest were found during the investigation. One patient, although the house was placarded, was found walking on the street; another child was found ill, attended by her mother who kept a grocery store in the same house; another child was ill in the family of a man who had a milk route. In all these cases the local board of health acted promptly when the conditions were brought to their attention, and necessary precautions were taken.

Six cases of diphtheria were investigated in Ware. Three of the cases were in one family, undoubtedly due to contact. The other 3 cases were from the same school, and in all probability had come in intimate contact. The local board of health, acting upon the suggestion of the State Inspector of Health, supervised the quarantine in the afflicted family and cleaned up and fumigated the schoolhouse. Two negative cultures were required before release from quarantine. No further cases developed.

A small outbreak of diphtheria occurred in one of the schools in Williamstown. These cases originated from a mild case of the disease which was discovered by the school physician while making a routine examination. All the patients were properly isolated, and after a few days no new cases developed.

An outbreak of 8 cases of diphtheria was investigated in Winchendon. No common source for the infection could be found. Suitable precautions were taken by the local board of health against the spread of the disease.

An outbreak of 16 cases of diphtheria was investigated in Winthrop. With the exception of 5 cases all attended the Center School, and were in all probability contact cases with one unrecognized case. Isolation in each instance was satisfactory. The schools in Winthrop were closed and remained closed for two weeks, including the spring recess. No new cases occurred.

SMALLPOX.

One case of smallpox occurred in Quincy, and the local board of health was assisted in its efforts to check the disease. Strict quarantine was maintained of the case and all those exposed were vaccinated.

One case of smallpox occurred in Lawrence. Assistance was given to the local board of health in the diagnosis of the disease.

One case of smallpox occurred in Needham. The case was properly quarantined and no new cases appeared.

Assistance was given to the local board of health in the diagnosis of a case of smallpox in Taunton, and suggestions were given as to the methods of quarantine and vaccination.

A case of smallpox was investigated in Wakefield on May 31, 1911. The case was a mild one. The patient was promptly quarantined at home, and the other members of the family and all those exposed were vaccinated. No other cases occurred.

On April 28 a case of smallpox was reported to the Winthrop board of health. The patient came from Nova Scotia three years ago and had never been vaccinated. The movements of the patient for several weeks previous to his illness were traced, and the people with whom the patient had come in contact shortly before his illness in Winthrop and in Chelsea were vaccinated. No other cases of smallpox were known to exist in Boston, Winthrop or Chelsea, and it was not clear where he contracted the disease. Of possible etiological interest was the fact that the patient had been receiving letters from Nova Scotia, where the disease was prevalent. The patient was removed to the Boston Isolation Hospital and all necessary precautions were taken by the Winthrop board of health. No further cases appeared.

CEREBRO-SPINAL MENINGITIS.

During March, 1911, 3 cases of cerebro-spinal meningitis occurred in Haydenville among emigrants from Greece who had first come to this country early in April, and a fourth case was reported of a Greek emigrant who had just landed and who came from the same town in Greece and was a personal friend of the other three patients. Proper precautions were taken by the local board of health and no other cases of the disease occurred.

In the latter part of April 3 cases of the disease occurred in Fitchburg; these were also emigrants who had come from Greek ports, and were apparently connected with the cases in Haydenville.

ANTHRAX.

Several cases of anthrax occurred among animals in Sheffield and Egremont. The disease was present in these places last year. Four of the cases occurred in Egremont. On investigation it was found that the carcasses had been buried in a pasture near the Green River, which furnishes a portion of the water supply to Great Barrington. To prevent any possible pollution of this stream the carcasses were exhumed and removed.

OPHTHALMIA NEONATORUM.

Three hundred and twenty-five cases of ophthalmia neonatorum were investigated by the State Inspectors of Health, and in every instance a detailed report was submitted to the office of the State Board of Health. These investigations consisted of visits to the homes of the patients and consultations with attending physicians and with local boards of health. The householders were instructed as to the necessary precautions to safeguard the eyes of the other members of the family, and whenever it appeared that home treatment was inadequate the State Inspector of Health urged upon the family, as well as the local board of health, that the patient be removed to the hospital. Such investigations of every case resulted in securing efficient treatment for patients and in preventing in many instances serious results.

During these investigations certain facts were observed which were of interest. It was found that in many instances the parents delayed in calling a physician, not attaching much importance to the "cold" in the baby's eyes. In many instances the cases were not reported promptly to the local board of health by the attending physicians; on the other hand, many cases were reported as ophthalmia when there was but a slight irritation of the eyes, in all probability due to the free use of silver nitrate. In one case, which was later treated at the eye and ear infirmary, it was the opinion of the physicians that the eyes were materially injured by the too free use of the silver nitrate. A communication was sent by them to the local board of health and to the attending physician, informing them of the results and advising greater caution in the use of this remedy. A great many boards of health were found who made no investigation of cases of ophthalmia reported to them. Their action consisted simply in forwarding such reports to the State Board of Health. The following are some typical instances met by the State Inspectors of Health during their investigations: —

1. An infant was found with badly inflamed eyes. He was not receiving the proper care. Two days had elapsed between the visit of the physician and the report of the case to the local board of health. The attention of the local board of health was directed to the case, and the child was sent to the hospital where it received proper treatment. If the conditions which were found at the time of the visit had been allowed to continue there is reason to believe that the child's eyesight would have been destroyed.

2. A case was found improperly treated by a private physician. The disease was progressing unfavorably and at the advice of the State Inspector of Health expert treatment was obtained. The child completely recovered.

3. A case was found in which the disease originally affecting one eye had, in consequence of improper care, spread to the other eye. The conditions were immediately brought to the attention of the local board of health. The child was removed to the hospital, where, under proper treatment, the sight was saved. Unfortunately, a corneal ulcer had destroyed the sight of one eye.

4. A case was found in which the disease was progressing unfavorably. No prophylactic had been used at the time of birth. There was a delay of four days in reporting the case to the local board of health by the attending physician and the treatment was inadequate. The local board of health was urged to take immediate action. The infant was placed under the care of a competent physician, and a trained nurse was put in charge. The child completely recovered.

5. Improper treatment and lack of care was in evidence in a case which was visited. No prophylactic had been used at the time of birth, and there was a delay of two days before the physician reported the case to the local board of health. The attention of the board of health was called to these conditions, proper treatment was instituted, and the eyes of the child were saved.

6. In another case no prophylactic had been used at the time of birth by

the physician, and four days had been allowed to elapse before reporting the case to the local board of health. The child's eyes were found to be badly inflamed, with a heavy purulent discharge. The conditions were brought to the attention of the local board of health, proper treatment was instituted, and the child's eyes were saved.

The efforts of the State Inspectors of Health have thus in many instances been the means of saving the sight of children that would have otherwise been destroyed through carelessness or neglect. The results achieved fully compensated the great amount of time which this investigation required.

STATISTICS.

The following data were obtained in the three hundred and twenty-five cases which were investigated: —

	Cases.
Prophylactic outfit furnished by State was received by physician or midwife in	263
Not received by physician or midwife in	25
Not known or not ascertained in	35
Outfit used at time of birth in	126
Outfit not used at time of birth in	170
Not known in	27
Reported within twenty-four hours, ...	133
Reported within forty-eight hours, ...	27
Reported within longer space of time, ...	146
Not known, ...	17

Condition of eyes when first seen by State Inspector of Health: —

	Cases.
Nearly well, slight or no discharge, slight inflammation in	139
Bad, discharging pus, swollen and inflamed in	114
Sight destroyed in	1
Not seen, transferred to hospital, or dead in	40
Normal or fully recovered in	29
Eyes of family properly safeguarded in	278
Eyes of family not safeguarded in	21
Not stated or cases transferred in	24
Home treatment was found adequate in	133
Home treatment was found inadequate in	22
Not stated or sent to hospital, ...	168

NUISANCES.

By nuisances is meant public nuisances, that is, objectionable conditions which affect the public or the community. In determining the existence of a nuisance, health, comfort, convenience and interest of the community are factors for consideration. In the matter of preventing, destroying or mitigating nuisances which endanger health the local boards of health have absolute authority. The function of the State Inspectors of Health is to investigate such nuisances if necessary for the purpose of bringing them to the attention of the local authorities and of recommending measures for the removal of objectionable conditions.

The more ordinary types of nuisances may be grouped as follows: —

1. Those created by emptying the sewage of dwelling houses through a private drain upon the surface of a private way on abutting private land.

2. Those which affect the purity of the sources of water supply, as, for example, the pollution of wells, springs, brooks and water courses, pollution of public water supplies by the disposal of manufacturing waste, the improper location of sewer outlets.

3. Those which make the occupation of neighboring houses and the passage over the adjacent highways disagreeable, as, for example, piggeries in which swine are kept in such numbers that their natural odors fill the air thereabout.

4. Those caused by privy vaults so situated as to be injurious to the public health.

5. Those caused by unfit dwellings which are liable to be a cause of sickness to the occupants or to the public.

6. Those caused by accumulations of manure, filth or refuse of any kind.

7. Those caused by land which is wet, rotten or spongy, or covered with stagnant water, so that it is offensive to residents in the vicinity or injurious to health.

8. Those caused by the exercise of any trade or employment which is hurtful to the inhabitants, injurious to their estates, attended by noisome and injurious odors, or dangerous to the public health.

9. Those caused by the emission of dark or dense gray smoke except under statute limitations.

During the year there were investigated in detail 170 nuisances in 20 cities and 86 towns. Of this number 68 were caused by offensive trades, odors or offensive accumulations of manure and other refuse; 46 related to cesspools or privies; 40 involved drainage conditions, stagnant water or the pollution of water supplies; and 16 were of a miscellaneous type. In 112 instances efforts were promptly made to abate the nuisances; in 24 instances it was found that the complaint was ungrounded, no nuisance existing; in 28 instances — owing to need of time for consideration by local boards or the State Board — the nuisances were recorded as pending; and in only 6 instances were the nuisances unabated because of failure to carry out suggestions made by the State Inspectors of Health.

The increased number of nuisances over last year brought to the attention of the State Inspectors of Health, either by citizens or by local boards of health seeking advice; the prompt action taken by local boards of health or persons responsible for the abatement of the nuisances; and the decrease in the number of nuisances unabated show results worthy of note, in that such results show increasing co-operation on the part of local boards of health and State Inspectors of Health, and an appreciation on the part of the public of the value of the services of such inspectors in their efforts to maintain desirable conditions in the several communities for the promotion of the public health.

Sanitation of Schoolhouses.

Owing to the change in the law governing public buildings, much that was previously done by the State Inspectors of Health has been turned over to the District Police. However, during the year 34 schoolhouses were inspected, distributed as follows: Amesbury, 3; Chelmsford, 1; Dalton, 2; Everett, 1; Hardwick, 1; Haverhill, 5; Lawrence, 1; Lenox, 1; Mattapoisett, 1; Middlefield, 1; Montgomery, 1; New Bedford, 1; North Adams, 1; Palmer, 1; Sandisfield, 1; Springfield, 1; Ware, 2; West Stockbridge, 1; Wilbraham, 1; Worcester, 7.

Of the three buildings visited in Amesbury the heating apparatus was constructed in such a way that some of the rooms were heated at the expense of the others, which tended to keep some of them overheated. In another, although the visit was made on a clear day, the air of the rooms was close and stuffy; in cold weather, owing to the arrangement of the heating apparatus, the front rows of seats were rendered uncomfortably hot, while if the windows at the back of the room were opened there would be a draught; on the whole, the State Inspector of Health thought it would be impracticable to install a new and proper ventilating apparatus, as the conditions were such that the building should be discontinued. In the other school, while the rooms were without artificial methods of ventilation, they were so large and roomy that the conditions were satisfactory; the privies, however, should be replaced by modern ones.

The grammar and high school building at Chelmsford Centre was inspected on complaint. Some of the rooms were found to be overcrowded, the sanitaries were frequently out of order owing to inadequate drainage and care, and about 25 boys ate their lunches where the air would be polluted at these times. The chemical laboratory had no ventilating hood, water supply or provision for emptying slops. In two rooms the seats were so placed that the pupils were not getting the best advantage of the light. A letter was sent by the State Inspector of Health to the school committee, setting forth these objectionable conditions, with suggestions for remedying the same.

Following several complaints of the unsanitary conditions existing at the Everett High School, and after several visits by the State Inspector of Health to the building, it was found that a system of closets existed, the ventilation of which was connected with the natural school ventilation and by which it was possible for odors to enter the different rooms. The school committee, through the board of health, were advised to close these closets temporarily until other arrangements could be made. Subsequently these closets were removed from the building and the usual water-closets introduced connected with the sewer. Thus the nuisance was corrected.

At Hardwick the new high school building was inspected.

The conditions in the five schools visited in Haverhill were found to be rather unsatisfactory. In two buildings the arrangement of the seats where the light entered from the rear and right of the pupils was to be criticised. In four buildings the heating and ventilating apparatus was open to criticism because the air supplied in winter is unnecessarily overheated and dry, and some method should be employed by which an adequate amount of moisture might reach the air of the class rooms. Two buildings were found to be without proper drinking water facilities. In the three buildings found to be inadequately lighted, the conditions could be remedied by whitening the ceilings, freshly tinting the walls and providing proper methods of artificial illumination.

In the schoolhouse visited in Lawrence, provision should be made for proper heating, ventilation and light.

At a school in Lenox, visited for the first time, the water-closets were found to be satisfactory and connected with the sewer. Automatic drinking fountains were also found to be installed.

Following an inspection and report in 1910 of a school in Mattapoisett, heating and ventilating changes were made with a view to remedying the findings made at that time. A short time after it was found that the newly installed heating and ventilating apparatus was a failure, and the State Inspector of Health was notified. This communication was sent to the State Board of Health, and the school authorities advised that such matters now belonged to the District Police.

The Middlefield, Sandisfield and West Stockbridge schools were inspected for the first time. These were wooden buildings, were heated by stoves, and were without ventilation except through the windows. There were in the three buildings eight rooms, with a total of 157 pupils in attendance. The lighting of the rooms was satisfactory, except that the rooms of the West Stockbridge School were gloomy because of dark tinting on the walls. The light reached the pupils from both sides, and in some rooms from behind as well. There were privies in all three schools; at one they were in fair condition, at another they were untidy, while at a third the privy was out of repair and unsuitable, being open and exposed.

A small country school in Montgomery was found clean, well lighted and ventilated. One child was found with impetigo contagiosa, and precautions were taken to prevent the spread of this disease.

In New Bedford conditions at the Westall School were brought to the attention of the State Board of Health, and by their order a thorough examination on a scientific basis was made. The findings were reported in detail to the State Board of Health, and a communication sent to the superintendent of schools which, in turn, reached the superintendent of buildings. A newspaper denial from those having to do with public buildings followed. Practically nothing was done to remedy the conditions found, and at the present time they are much the same if not worse. The same public dissatisfaction continues, complaints are just as numerous, and apparently nothing further will be done.

The schoolrooms in the Ellis building, North Adams, continue damp, and are in no way suited for the purpose in hand, as has been previously mentioned.

A grammar school in Palmer was inspected on account of the numerous cases of diphtheria occurring in one of the rooms. The place was well lighted, the light coming from the rear and over the left shoulder, the ventilation adequate, and it was found remarkably clean. In the basement were sanitary drinking fountains, and paper towel rolls were provided. The only objectionable conditions found were the overcrowding of the rooms, but provision is being made to eliminate this by transferring some of the pupils to a new addition under construction.

In Pittsfield the school inspection has been very indifferently carried out. The matter was brought to the attention of the board of health and the school committee, but without special results, except that a physician has been particularly employed on one or two occasions in connection with cases of communicable diseases.

In Springfield a schoolhouse containing 340 pupils was found to be well lighted, the light coming from the rear and left side of the rooms. The rooms were well ventilated except one, where the kindergarten children assembled; the thermostat here was broken.

Two schoolhouses were inspected in Ware in connection with the investigation of diphtheria among the pupils. One was an old building, but clean. The objectionable conditions found were washbowls in the class room, lack of sanitary drinking fountains, and an insufficient number of water-closets. The other school was modern and clean; the light was excellent, coming from the rear, and over the left shoulder. The closets on the boys' side needed repairing, also suction required over the urinal. The condition of the hall register was not satisfactory, as the air from the cellar came up through this; it should be boxed up, and connected with the outside air through a flue.

An inspection of the Wilbraham Academy showed that the buildings were old and very much in need of improved sanitation. This institution has closed its doors, and it is questioned whether it will ever be occupied again.

The following are several instances which show that the recommendations of the State Inspector of Health have been carried out in the city of Worcester; the sanitation in one school has been improved; land has been purchased for a new building, also for an addition to an old building; extensive repairs have been made on another; a new building has been built; another building has been changed from a graded to a high school building. In several cases portable buildings have been erected in different parts of the city to accommodate the buildings already overcrowded or those in process of construction. Some of the school yards have also been oiled.

DRINKING WATER.

Following the passage of Chapter 491 of the Acts of 1911 — an act relative to the furnishing of drinking water on passenger trains — the State Inspectors of Health were requested to take particular note of the drinking-cup facilities on passenger trains running within the districts, to ascertain whether (*a*) individual drinking cups were accessible to the passengers; whether (*b*) a sufficient quantity of pure drinking water was provided in such place or places in the car as was convenient for the passengers in accordance with the provisions of Section 1 of the act in question; whether (*c*) any improper use was made of the tanks or their covers; and whether (*d*) they approved of the cups supplied or methods of furnishing the drinking water to the passengers.

It appeared from the reports of the State Inspectors of Health in reply to the circular letter containing the above request that the railroads were making an effort to comply with the law so far as providing individual drinking cups was concerned. There appeared, however, to be a very general disposition not to exceed the requirements of the law, in that no cups were provided where the train run within the State was less than 30 miles.

While the cups in general use were of the flat, paraffine paper type, circular cups were noted in some instances. These were occasionally left at the tank after use where other persons might use them.

In many coaches notices were posted at or near the water tank, stating that although the common cup had been abolished, individual cups might be obtained upon application to the trainmen. While notices were found in some coaches, such instances were not universal.

The use of a mechanical holder for cups appeared to be more desirable than the custom now in use of a trainman's handling the individual cup.

Full information in regard to the supplying of "a sufficient quantity of pure drinking water" is not here given, but it is interesting to note that one inspector found, in the course of his observations in connection with this subject, on 41 trains, including 117 passenger coaches, but one instance where he considered the law was not complied with. In this one instance the water in the container was not proper for drinking purposes.

It was noted in many instances that in industrial establishments there was a growing tendency to use the individual drinking cups. In many places no cup was seen attached to the drinking receptacle, each employee having one of his own.

In connection with the common drinking cup the following is quoted from an inspector's report: —

> I wish to invite the attention of the Board to the unsanitary methods that are in use in most soda fountains. There are a few, it seems to me, who are conducting their business in a satisfactory way. Each customer gets a glass that has been washed out in hot water and soap. After they are used they are allowed to accumulate and then taken out to the rear of the store and washed thoroughly as stated above. From my observation in the matter it is impossible to wash these glasses by simply rinsing or spraying them with cold water. It will not wash milk off satisfactorily, and there is sometimes a deposit of mucus from the lips of the drinker that will require hot water and soap to remove. Some of these fountains are filthy, and glasses are simply rinsed in a bucket of water behind the counter which is used over and over again for this purpose. The same observation applies to spoons that are used in ice cream. Simple washing in cold water of these spoons will not clean them from a hygienic point of view.

MATTERS RELATING TO WATER SUPPLY AND SEWERAGE.

A number of inspections were made during the year of the water supplies and sewerage systems throughout the State.

The investigations led to the condemnation of a number of water supplies, both public and private, and to suggestions from the State Board of Health for remedying existing conditions.

The inspections of the various water supplies and sewerage systems are as follows: —

WATER SUPPLIES.

Auburn. — An investigation of the water supply resulted in the closing of two wells.

Cheshire. — Owing to continued complaints concerning the water supply, in company with a representative from the engineering department of the State Board of Health, a careful survey of the water supply was made and a report submitted to the State Board of Health. In consequence, the State Board of Health recommended the discontinuance of the use of water from Thunder Brook until measures should be taken to prevent danger of pollution from the buildings on the watershed.

Fairhaven. — An investigation of the wells in the section of the town where a number of typhoid fever cases existed led to the prohibition of their use for drinking water purposes and the installation of town water. The water supply at a slaughterhouse was examined, condemned, and the owner advised to furnish a new supply; the water supply of a milk farm was examined on account of typhoid fever and the local authorities advised; and the water supplies of Harbor View and Sconticut Neck were investigated.

Fall River. — The water supply of the Durfee Mills was investigated and city water substituted for the pond supply.

Greenwich. — An analysis of the water from a spring used by summer cottagers proved it to be safe for drinking purposes, and a letter was written to the owner making suggestions to protect it from contamination.

Haverhill. — On account of the large number of complaints received relative to the water supply in the Riverside district, the water board issued a statement through the public press reassuring those who feared contamination of this water supply.

Holyoke. — An investigation of an alleged spring in one of the playgrounds showed that the water came from a thickly populated section of the city and was at times polluted with sewage. From a consultation with a former park commissioner it was learned that the water was not intended for drinking purposes, but through faulty piping was not carried far enough into the river, thus allowing people to drink from it on the bank. The State Board of Health regarded the so-called spring as a very dangerous source from which to take water for drinking and recommended that its further use for that purpose be prevented.

Hudson. — Conditions surrounding wells at Lakeside village, where typhoid fever existed during the summer of 1910, were investigated. As no evidences of pollution were found, no analysis of the water was made.

Lexington. — An examination of the spring furnishing drinking water to the Jefferson machine shop showed it to be badly polluted. Its use was discontinued and spring water is now furnished the operatives.

Lowell. — An investigation concerning the danger of lead poisoning in the Cook well district showed that many of the houses were piped with lead. An examination of several persons revealed symptoms and traces of lead poisoning.

New Bedford. — The water supply of the Crescent mills was investigated, analyses made and city water installed. The water supply of the Beacon mills was examined, samples taken, analyses made and a communication from the State Board of Health sent to the management; the supply was discontinued and a new system for furnishing drinking water installed. The water supply of the Sassaquin Sanatorium was examined, samples taken, analyses made and the authorities advised by the State Board of Health. The water supply of a typhoid fever case was investigated.

North Adams. — Owing to abundant rainfall the city has not been obliged to use the Ashland Street wells. As yet no definite steps have been taken towards increasing the city's water supply.

North Wilbraham. — An outbreak of typhoid fever led to an investigation of the water supply of a manufacturing concern, suspected of being the cause of the spread of the disease. The State Board of Health, as the result of a combined investigation by the State Inspector of Health and the engineering department, recommended that a suitable water supply for drinking and domestic purposes be provided in the mill and tenements.

Pittsfield. — The city is constructing a large reservoir for the storage of additional water supply on Mill Brook, October Mountain, in the town of Washington. Owing to the large number of workmen engaged on the project and the great amount of surface drainage entering the supply pipe without opportunity for sedimentation to take place the city was advised, early in the spring, to discontinue the use of Mill Brook while construction work was in progress. Since then, no water from that source has been used in the city. Frequent visits to the site of the work and suggestions have been necessary to secure sanitary conditions.

Southbridge. — An investigation of a water supply resulted in advising discontinuing the use of water from a well by a family in which two cases of typhoid fever had been found.

Townsend. — A committee has been appointed to look into the matter of a public water supply for the town, and the matter is still under consideration. The schoolhouse well at Townsend Centre has been condemned by the State Board of Health.

Sewerage Matters.

Amesbury. — The town requires a proper system of sewage disposal.

Ashburnham. — Drainage conditions have been much improved during the year. Sewage has been removed from the principal brook running through the town and drainage conditions upon the premises of a number of householders have been improved by the construction of cesspools.

Haverhill. — The municipal council was asked to take some action towards abolishing the nuisance caused by the large amount of sewage and manufacturing waste in Little River, which flows through the center of the city. No action was taken.

North Adams. — An interview was held with the city engineer concerning a proposed change in the outlet of the main sewer to diminish the nuisance arising from stagnant sewage. The only action taken was to change slightly the channel of the river, thus directing the main current of the stream past the opening of the sewer, partly abating the nuisance.

Westport. — The Y. M. C. A. camp was inspected with reference to water-closets and was relocated.

SANITATION OF FACTORIES AND WORKSHOPS.

Cleanliness.

An improved condition as to cleanliness was noted in a number of factories and workshops which had been previously inspected. In the main, the conditions demanding attention were of a minor nature. As a rule, a reasonable degree of cleanliness was found to be maintained in most manufacturing establishments. In many of the larger establishments considerable attention was given to the matter of cleanliness, and in many, commendable conditions were observed.

Ventilation.

Considerable attention has been given in recent years to the study of the factors which exert an injurious influence on the health of occupants of poorly ventilated rooms. As a result of investigations such as those of Flügge and his pupils in the Breslau laboratory in 1905, and more recently those of Benedict and Milner in the experimental station of the United States Department of Agriculture, the tendency among sanitarians is to attach greater importance to the temperature and humidity of air rather than to its carbon dioxide content. Many investigators maintain that the CO_2 content of the air is an inadequate index of its purity, that a high content of CO_2 is not necessarily an indication that the air is impure, and that of far greater consequence than the CO_2 content is the proper regulation of the temperature and humidity of occupied rooms. The ill effects experienced in poorly ventilated rooms is said to be not due to lack of oxygen or excess of carbonic acid gas with its concomitant impurities, but to excessive temperature and humidity usually prevailing in poorly ventilated rooms. The latter two factors injuriously affect the general body metabolism, inasmuch as they interfere with the proper evaporation of the sweat from the body surface and moisture from the mucous surfaces and thus disturb the temperature equilibrium of the body.

Certain observations made by the State Inspector of Health for Suffolk County tended to support these conclusions. For example, the temperature in dipping rooms in chocolate factories must be kept, in order to maintain the consistency of the chocolate, at uniform point, 66–68° F. During the summer months, therefore, these rooms are cooled by refrigerating pipes. To keep out the hot air from the street all the windows are kept closed, so that little fresh air gains access to the dipping rooms; and as they are quite apt to be crowded with employees the CO_2 content is rather high. Yet on entering these rooms from other parts of the factory the effect was refreshing, due, undoubtedly in the main, to the comparative coolness of the air and also to the relative low humidity caused by the precipitation of the moisture on the refrigerating pipes.

An investigation is now in progress in several selected industries to determine the existing conditions as to temperature, humidity and CO_2 content, in the hope that the results will demonstrate the relative importance of the various factors as standards of good ventilation.

A number of spinning rooms in cotton mills were measured and tested for cubic capacity per capita and condition of the air. In the spinning rooms examined the per capita air space was large and the air condition was pretty uniformly fair. Old, narrow mills in which the machines ran lengthwise of the room gave, as a rule, better results than the broad ones, but the light was not quite so good. Old mills tested showed approximately 6 parts of carbon dioxide to 10,000 parts of air; the new mills showed about 7 parts of carbon dioxide to 10,000 parts of air.

The following are examples of conditions of poor ventilation which were found in various factories and workshops by several State Inspectors of Health; in one instance escaping smoke from oil furnaces vitiated the air in a large machine shop; in a cracker factory there was much escape of gas from the gas-heated ovens; a large stitching room of a shoe factory was objectionably filled with fumes from naphtha cement; in an old iron foundry the ventilation was poor because of improper use of the ventilators; in a brass foundry fumes of metals, some toxic, were inefficiently removed; a similar condition existed in an electrotype foundry; in an incandescent lamp department a number of employees, of whom some were minors, were exposed to overheat from the fires at which they worked; a similar objectionable condition existed in a glass-blowing department. In all of these specific instances, as well as in others not herein mentioned, an improvement was brought about by written orders and recommendations of the State Inspectors of Health.

Occasionally it was found difficult, even by the expenditure of large sums of money, for a manufacturer to improve satisfactorily the ventilation of his premises; for instance, in a large iron foundry where the removal of gases and vapors was inefficient, although an additional monitor roof was placed in position and experts were asked to devise some adequate method of removal of the gases and vapors at the time of pouring off, no expert would guarantee any system, at however great expense it was installed, that would efficiently remove the fumes.

Removal of Dust. — As in previous years attention was given to enforcement of the laws in regard to the removal of dust created by different processes in different industries. There was noted on the part of some employers a disposition to comply with the letter of the law only, while occasionally there was a tendency to install some device which had a semblance of complying with the law, but which was entirely inefficient. In one instance, upon the order of a State Inspector of Health an entire outfit for the removal of dust from emery wheels was removed and a new and efficient one installed. On the other hand, it was unfortunately a too frequent occurrence for the workman to remove hoods, often installed at considerable expense, under the claim that the hoods interfered with the work, an attitude which was untenable from the fact that in other establishments where similar work was carried on the workers found no difficulty with the hoods. It appeared to result from the lack of sufficient realization on the part of the workers of the dangers to which they were exposed, and also from the indifference on the part of some employers who failed to insist upon a proper use of the appliances provided.

A State Inspector of Health, as a result of investigations in the shoe industry, reported that a great deal had been accomplished in improving systems for the removal of leather dust created by the industry. In many of the establishments it was found that the whole system was inadequate for the proper removal of the dust, the principal reason for this being that the industry had outgrown the system in use by the continual addition of machines which affected it in its entirety. Likewise, faulty and ill-adjusted hoods, loose connections, leaky and clogged pipes — together with inefficient exhaust fans run at inefficient speed — individual fans running into a general system, and defective dust separators were the principal causes that were found to render some systems ineffective. Following these investigations orders were issued by the State Inspectors of Health, and many excellent systems were installed in the shoe factories, while other systems were so improved that they are now at least adequate.

The number of written orders to provide proper appliances for the removal of dust, issued during the year, appears in the table of statistical data.

Light.

The subject of proper lighting of factories and workshops received special attention during the year. Special observations were made as to the relation between the amount of light and the work done, as to whether it was adequate or inadequate; the kind of light if artificial, as to whether the operatives were exposed to direct glare of natural or artificial light. Likewise the effects of certain processes on vision and the occurrence of injuries to the eyes were studied. As a rule, it was found that processes requiring sharp vision were carried on near windows where the light was sufficient. In many instances the operatives were exposed to the direct glare of incandescent lights so that it was deemed necessary for the State Inspector of Health to recommend green shades for the lights. In one instance the process of testing tungsten lamps exposed four women to a light, dazzling in its brilliancy, directly in front of them; at the request of the State Inspector of Health smoked glasses were provided for the women. In this same factory the process of winding fine wire required sharp vision and excellent light; all of the windows in this room were shaded and every operative had a tungsten light in front of her, well shaded by a reflector, which provided excellent light and at the same time protected the eyes of the operatives from the direct glare. In this factory, although the sanitary conditions were excellent in every way, the frequency of headaches among the minors was striking. In many instances this was undoubtedly due to eye strain, as many of the processes required acute vision. The parents of all these minors were advised to have the eyes of their children examined.

In many of the machine shops visited inquiries were made as to the frequency of injuries to the eyes from particles of metal, more especially among those working on lathes. Such injuries were found to be rather frequent, but as a rule not serious. Usually one employee was found in every establishment who had acquired considerable skill in removing such particles from the eyes, and but rarely it was necessary to call a physician. The eyes of a number of older employees were found to be free from corneal scars or opacities resulting from injuries. As a rule, the men objected to wearing eye shields on the ground that such would interfere with their work, and appeared to attach little importance to the dangers from flying particles of metal.

Occasionally, men working on emery wheels at dry grinding were found to suffer from irritation of the eyes from emery dust, but objected to wearing glasses, maintaining that the wearing of glasses would increase the danger. In one establishment a piece of metal struck the eyeglasses of a workman and his eye was cut by the broken glass.

Burns of the eye occasionally occur in the work of soldering, but the burn is usually slight. Occasionally, however, the results are more serious, and one workman was found almost blind in one eye as the result of such a burn which became infected. Had he worn an eye shield at his work this would not have occurred. Similarly, men working in foundries, electrotyping establishments, etc., are in danger of burns about the eyes from molten metal. It appears that the wearing of protective goggles in such places is not impractical.

Employees in certain so-called dusty trades were found to suffer occasionally from irritation of the eyes from the dust. Thus, in the mattress industry and in the curled hair business dust sets up an irritation of the eyes. So, too, in hat factories, in combing and pressing beaver hats, the fine hair flying in the air often sets up an irritation of the eyes which is never of a serious nature.

In the cut-glass industry, again, a State Inspector of Health was informed by oculists who had practiced among the glass workers for many years that chronic and acute inflammations of the eyes, often very obstinate to treatment, were very common among the cutters, and that simple inflammations of the eyes were often seen in glass blowers. In the case of the cutters, the inflammation was due to minute spicules of glass and fine sand, while in the case of the glass blowers the inflammation was due to the intense heat at the mouths of the heating furnaces. Few or none wore glasses, and those who did wear them did so on account of defective vision rather than to protect the eyes from injury.

Occasionally, poor light in a factory was beyond the control of a proprietor of the factory. In a large shoe factory a row of trees within 10 feet of the windows on one side of the factory obstructed the light on that side of the factory. The trees were on property not owned by the proprietor, and the owner was unwilling to cut them down notwithstanding the fact that he was offered a substantial sum of money and their removal would in no way injure the property on which they stood.

The most unfavorable conditions of lighting were found in some small shoe manufacturing establishments. The unfavorable conditions were caused by the buildings being placed so close together, by the dingy interiors of the shops, and sometimes by the location of workrooms in the basements.

In the more recently constructed buildings provisions for proper lighting of the buildings were made.

Poor light in factories was sometimes found in the afternoon, and was the result of the unwillingness of the proprietor to turn on the electricity soon enough.

The State Inspector of Health of Southern Bristol County made a study of lighting conditions in the cotton industry in Fall River and New Bedford. Many of the old mills were found either entirely or partly lighted by gas. The light was of such poor quality as to cause severe strain on the eyes. Moreover, the overseers and their subordinates defer lighting up so as to keep the lighting expenses down to a minimum. The operatives are thus kept working for a time before the lights are turned on, although it is so dark that they can hardly do their work properly.

In the cotton mills where electricity is used for purposes of illumination, and where it is generated on the premises, the light is apt to be poor during the last of the day, resulting from the diminution of pressure of the steam as one machine after another ceases to operate. The 16-candle power bulb was the one in general use. These were, as a rule, unshaded.

One hundred drawers-in, all adult females, in the cotton mills were questioned. Practically all were obliged to wear glasses while at work despite the fact that the natural light was exceptionally good and that they were properly placed regarding the light. Artificial light, when needed, was supplied by electric bulbs of sufficient power, properly hooded and advantageously placed. The exacting nature of this work, the fineness of the thread and the great number of harnesses used make this work exceedingly trying to the nerves and to the eyesight. Fully 50 per cent. suffered from nervous strain. More especially was this the case in those who had been long employed at this work. The ages of these women ranged from nineteen to thirty-one years.

Forty-two inspectors engaged in correcting, grading and classifying various defective pieces of cloth were examined. This work called for exceptionally good light, both natural and artificial. In the several mills visited the light arrangements for this work were excellent, proper regard being paid to location, shading and hooding of lights in order to obtain the best results with the least possible injury to eyesight. None of the inspectors showed any ill health but, on the other hand, many showed signs of eye strain and nearly all wore glasses.

Certain processes of manufacturing unavoidably cause eye strain. For example, "hot straightening" of small drills is conducted in dark rooms and requires very acute vision, and if performed for months and years is apt eventually to injure eyesight. Again, the process of "hardening" small tools is conducted in a darkened room and requires the operative to judge the temperature of molten lead by its color, which must be very trying to the sight, although among those questioned none admitted any injury to his sight. The modern method of determining the temperature of the metal by the pyrometer is gradually doing away with this possible source of injury to eyesight.

Drinking Water Supply.

In two very large shoe factories town water was so introduced that it was possible for the employees to obtain chilled water in place of spring water previously used, for which the operatives had to pay.

In a large jewelry factory the water supplied to the workers from an old well was found by analyses made by the State Board of Health to be polluted to an extent that made it impure for drinking purposes. At the request of the State Inspector of Health the use of the well water was discontinued and an adequate supply of pure water was obtained from the public supply of the town.

The premises about a spring from which it was proposed to take drinking water for a dye works and bleachery employing 100 hands were examined by a State Inspector of Health. Analyses of the water made by the State Board of Health showed pollution, and subsequently the town water was introduced as the supply of drinking water for the factory.

In a cotton mill the use of the ordinary pail and dipper was abandoned and porcelain receptacles with faucets were provided.

Minors engaged in Processes Injurious to Health.

During the year 143 minors were found employed in processes declared by Chapter 404, Acts of 1910, injurious to health. Of that number 63 were males and 80 females. The processes at which the minors were employed and the number of minors at each process were as follows: —

Involving exposure to lead and dust of plumbago in electrotyping establishment,	1
Typesetting, cleaning and handling type in printing offices,	12
Cutting, boring, turning, grinding, facing or polishing pearl shell,	13
Talc dusting in rubber works,	8
Exposure to naphtha in the shoe and rubber industry,	104
Dipping metal in acid solutions,	5
	143

Of the 143 minors found employed in these processes injurious to health 18 were transferred to other departments in the same factory, 16 were excluded from the factory, and 109 remained at work because of special means adopted which appeared to the State Inspectors of Health to be efficient in protecting the minors against dangerous influences.

SANITARY CONDITIONS IN LAUNDRIES.

An investigation was made throughout the State of conditions existing in public laundries. Practically all laundries in which five or more persons were employed, as well as some in which less than that number were found, were examined, the sanitary conditions noted, and inquiries made relative to the effect of the work upon the health of those engaged in it.

Public laundries may be separated into four groups: (1) Chinese, (2) wet-wash, (3) steam, and (4) wet-wash and steam combined. Chinese laundries seldom employ more than two or three persons, generally males, and are not considered in this report. The wet wash is a variety of laundry which has recently become very common. The essential difference between a wet-wash laundry and a steam laundry is that in the former soiled clothing is washed, partly dried and returned to the owners in a damp condition, whereas in the steam laundry the clothing is washed, completely dried and ironed. For the reason that no starching or ironing is done, the number of employees in a wet-wash laundry is much smaller than in a steam laundry, and for the same reason the sanitary conditions in wet-wash laundries differ somewhat from those in steam laundries. It is possible for four or five people to conduct a fairly large wet-wash laundry.

The industry gives employment to a large number of people of various nationalities, the majority of whom in steam laundries are females, in the ratio of five women to one man. In wet-wash laundries, however, the ratio is two men to one woman. A steam laundry employing seventy-five persons is a large laundry; the majority employ a much smaller number. Few wet-wash laundries employ more than ten persons; by far the greater number employ but four or five. Relatively few laundry workers are less than eighteen years of age. Such minors were rarely found in wet-wash laundries, while in steam laundries they seldom exceeded one-tenth of the total number of employees, were usually less than that proportion and in many laundries there were none. The statement was made by a number of the women that they preferred work in the laundry to that in cotton, silk and woolen mills, or in jewelry, straw hat and other factories, in which they had been previously employed.

THE INDUSTRY.

Buildings. — The industry is carried on in all kinds of buildings. Wet-wash laundries, requiring less space than steam laundries, were found in small, isolated buildings built for the purpose; occupying one large room on the street floor of business blocks; in old schoolhouses, churches, barns and similar buildings often unsuited for other business. Steam laundries were found in larger buildings of varying types. Small steam laundries conducted all processes on one floor or on one floor and a basement; larger laundries used two floors and the basement, while the largest used buildings of three stories and basement. As will be shown, the building equipment and the arrangement of the rooms were found to have a distinct bearing upon sanitary conditions; the better the building and room arrangement the better were light, cleanliness and ventilation. Some laundries have become, with increasing business, relatively overcrowded. It was the exception to find a laundry using a building originally constructed for such purposes. The standard of excellence in such buildings was markedly higher than in other buildings so used.

Nature of the Work. — Laundries divide their work into wet-wash, flat-work and starch work. The bundles of soiled clothes, gathered from many sources, are sorted into compartments or bins, according to the nature of the work in them. The bundles are then opened and the contents counted, sorted and recorded by women who are known as "sorters" or "markers-in." Especially dirty clothing, requiring more washing, is separated from the cleaner. The clothing then passes to the wash room. The washing machines are revolving, cylindrical affairs known as "wheels," turned by power. For wet wash, which is ordinary family wash, the clothes are put into the wheels with cold water for five minutes, then soaked and bleached for twenty-five minutes, then three scaldings with hot water and rinsing for five minutes each, then cold water for five minutes and then five minutes in cold-water bluing. The chemicals used in a wash room are chloride of lime, rarely weak solutions of oxalic acid, and ordinarily acetic acid in preparing the bluing. Potash and soda soaps are chiefly used. In no laundry was there observed any injurious effect from the use of chemicals.

After being taken from the washing wheels the clothes are put into extractors or power wringers, by the centrifugal force of which the excess of water is removed from the clothes. The clothes are then removed from the extractors, shaken out, by women as a rule, and replaced in wooden boxes, in which, in a damp condition, they are returned to their owners. Washing wheels and extractors are tended by men. The work of wet-wash laundries is done on the first three days of the week and they are practically closed the remainder of the week.

Flat work, after being subjected to the treatment just described, is ironed, after coming from the extractor, by a machine heretofore generally called a mangle, but now called by the trade a "flat-work ironer." This machine varies in size from 6 to 10 feet in length and from 4 to 6 feet in height. Women and girls on one side of the ironer feed sheets, towels and other flat pieces between large, cloth-covered, steam-heated cylinders, to be removed and folded by women and girls on the other side of the machine, which varies in width from 4 to 6 feet. In order to do the work properly the women and girls usually stand on raised platforms, which are a part of the machine, and constantly reach to and fro over the machine, although they are not obliged to do heavy lifting. The folded flat work is then returned to the owners.

For starch work the wash-room processes are doubled in time for each process, and after coming from the extractors the pieces are starched on starching machines, which are usually tended by women. Standing on one side of the machine one woman feeds the pieces into the machine, which delivers them, saturated with wet starch, to the woman on the other side. This work, while light, is monotonous. The garments are then hung on hooks or forms attached to an endless rack, which slowly carries the pieces through a tightly closed, steam-heated chamber known as the "drier," from which the clothes come out thoroughly dry. This process consumes from twenty minutes to an hour.

From the drier the clothes go to the finishers or ironers. For the most part these are adult women, as the processes require care, skill and experience. Few minors were seen at ironing machines. Ironing is done by means of hand irons and by power-operated machine irons, heated by gas, gasolene, steam or electricity. The tendency is to use steam as much as possible as the work is done better by this heat. Hand irons vary in weight from 6 to 35 pounds. The smaller irons must be constantly lifted, but the heavier irons are constructed with supporting apparatus, the chief work being to push the iron to and fro. Constant standing is necessary in all ironing processes. There are different machines for the ironing of the bosoms, collars, cuffs, neck bands and bodies. On a bosom iron many of the women iron as many as 350 bosoms daily. The body ironers are machines for ironing the bodies of coats, etc. The garments pass through steam or gas heated revolving cylinders, which are made to approximate each other by the weight of the worker, in every instance a woman or girl, which is thrown upon a treadle operated on some machines by the left leg, on others by the right leg. Inasmuch as the finish of the work is dependent upon the amount of weight put upon the treadle this work is very fatiguing and laborious. One type of machine, however, was so made that the operative merely stepped down upon the treadle, and so was not obliged to lift her foot and bear down with all her weight, as on some of the machines. No especially laborious process was observed in connection with any other machine ironer.

In the finishing room of some laundries such processes as sewing on buttons, repairing and darning are performed, usually by machines.

From the finishing room the clothing is returned to the sorting room, checked and bundled for delivery.

Male employees attend the engine, boiler, washing machines, extractors, and may assist on the flat-work ironer. Female employees sort, mark, tend the flat-work ironer, ironing machines, hand irons, starch machines, check and bundle for delivery. Minors, in all instances girls, work on starching machines, commonly on flat-work ironers, rarely on body ironers and more rarely on hand irons; occasionally they sort, mark and check.

The arrangement of the machines depends upon the quarters occupied. In some laundries all machines are on the same floor, in one room or in two rooms, which may or may not be divided by partitions; in others, the washing may all be done on one floor, the ironing processes on another; or, again, the wash room may be on one floor, the flat work on another and the finishing work of starched goods on another.

INFLUENCES RELATING TO THE HEALTH OF EMPLOYEES.

Contact with Infectious Material of Soiled Clothing. — It would seem that in the operation of sorting and marking soiled clothing the women and girls who do this work must be in considerable danger from contact with infectious material. In almost all laundries the statement was made that drivers were instructed not to accept any laundry from premises on which infectious and contagious diseases were known or suspected to exist, and it appeared to be the general custom for laundries to refuse to accept unusually filthy clothes. There can be but little question, however, that linen soiled with typhoid excreta and tuberculous sputum is often taken into laundries, and the sorters are exposed to contact with it. The danger from contact infection is somewhat diminished by the skill with which an experienced sorter handles the goods with the least amount of contact. Very careful and thorough questioning in nearly all of the laundries, both from superintendents and from many of the workers, as to the frequency of contagious diseases among those in contact with soiled clothes, gave absolutely negative results. In some instances, however, it was acknowledged that such animal parasites as pediculi capitis and bedbugs were occasionally acquired by such contact.

General Fatigue and Ill Effects consequent to Prolonged Standing. — With few exceptions, all laundry workers of both sexes stand all day while at work. In some establishments seats were provided for those women and girls who folded such small pieces as towels and napkins; rarely they were provided at starching machines, but such seats were exceptional, and as a rule it was maintained that the work could not be satisfactorily performed if the operators were seated.

In large laundries the employees are kept at the same work all the time, but in the majority of the smaller laundries an employee may do several parts of the work, so that he does not stand in one spot all day, but is moving about from place to place. About forty hours was the general average weekly employment for the women operatives. This time was not evenly distributed, but certain days were longer than others. On Tuesdays and Wednesdays, for instance, in steam laundries the women were apt to be at work, hence to stand continuously, from 7 to 12 and from 1 to 6, while on the other days of the week the period of time was considerably shorter. Men, as a rule, worked ten hours every day except Saturday, which was a short day.

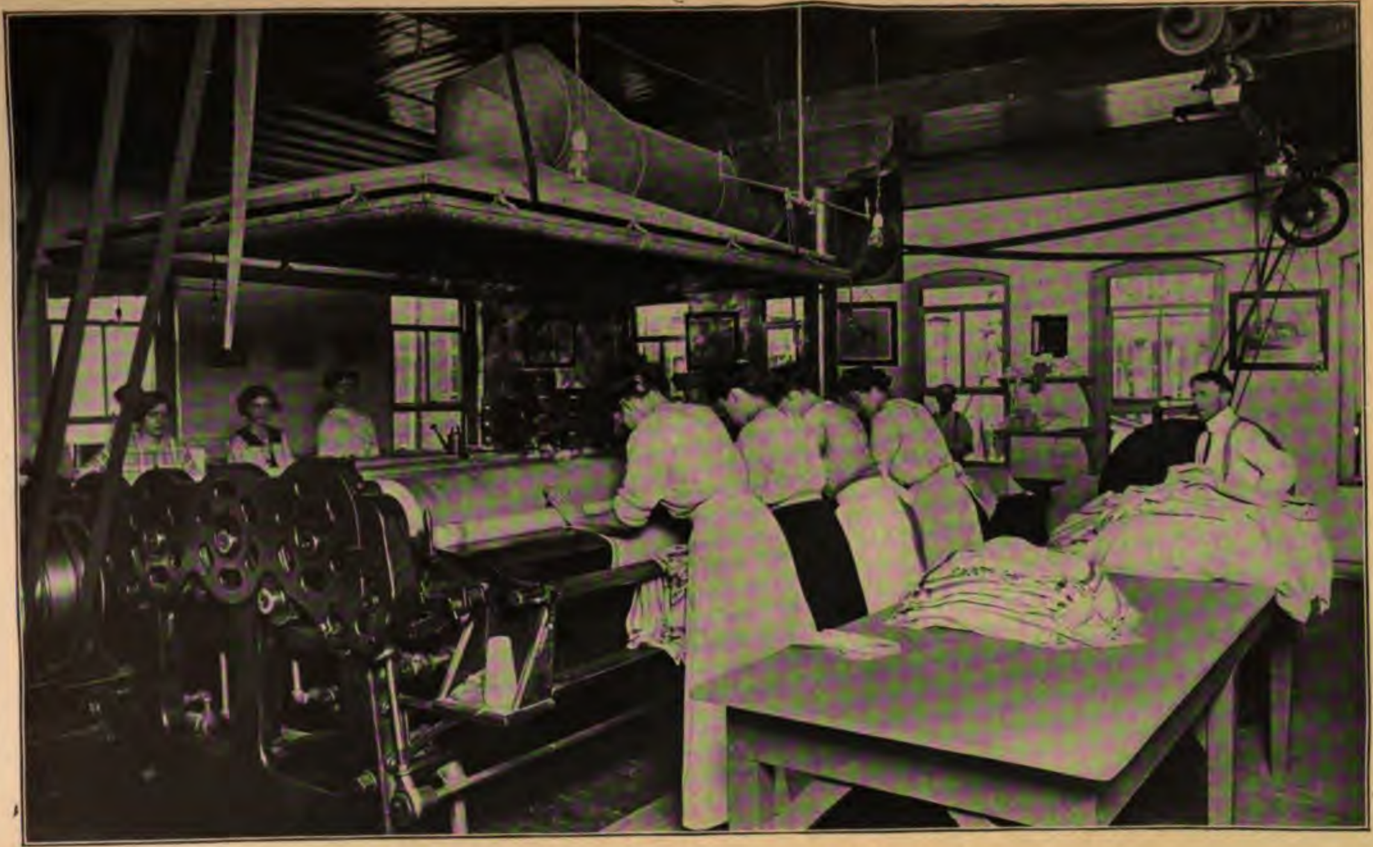
Although it was obviously impracticable to verify their statements by physical examinations, a large number of the women and girls were interrogated as to ill effects upon them of the constant or prolonged standing. While a certain number complained of sore feet, broken-down arches and varicose veins, the number of employees who experienced ill effects from long standing was surprisingly small. Painful corns, at times somewhat crippling the women, were rather commonly noted. Cases of trouble with feet and legs were rather more common among those who operated the pedals of the body ironers, previously described, than among other workers. The combination of constant standing and constant use of the treadles of these machines appeared to be very fatiguing. Several forewomen who were interviewed stated that dysmenorrhœa was a common affection among women employed in laundries. This, possibly, may be the result of long standing. Very few, if any, minors were found to complain of any ill effects of long standing; this may very well be due to the short time they had been at this work.

Excessive Heat and Humidity. — The processes carried on in laundries unavoidably create high temperature and often damp air. In wash rooms the washing wheels, starching machines and centrifugal driers create steam and moisture and cause wet floors. In many laundries suitable fans and ventilating stacks were provided to remove the excess of steam from the wash rooms, while wet floors and consequent wet feet were avoided by properly constructed floors and floor drainers under the machines. On the other hand, in many of the smaller laundries no fans were in operation, the steam was slowly carried out through windows and doors, the floors were often wet and sloppy and the air was oppressively damp. Few women were found employed in wash rooms, and with one or two exceptions no women were found standing upon wet floors.

While, in order to conserve the heat of the ironing machines, the effort is made to remove from the flat work as much water as possible before the work reaches the ironer, still the articles are in a damp condition, and in their passage between the steam-heated cylinders of the machine give rise to much steam. Above and in the immediate vicinity of the machines the temperature is high and the air nearly saturated with moisture. In the winter the humidity is apt to be even higher when the entrance of cool air through windows and doors reduces the temperature of the air in the room and precipitates the moisture. In some instances the flat-work ironing machines were provided with overhead hoods connected by suction pipes with exhaust fans, so that the steam as it was generated did not disperse through the room but was carried off through the hood. The greatest number of the machines, however, were not so protected. Exposed as they are to overheat and excessive humidity, those who work on flat-work ironers are peculiarly susceptible to drafts, and for that reason in some laundries exhaust fans and electric fans near flat-work ironers were often not in operation, the women complaining of the drafts.

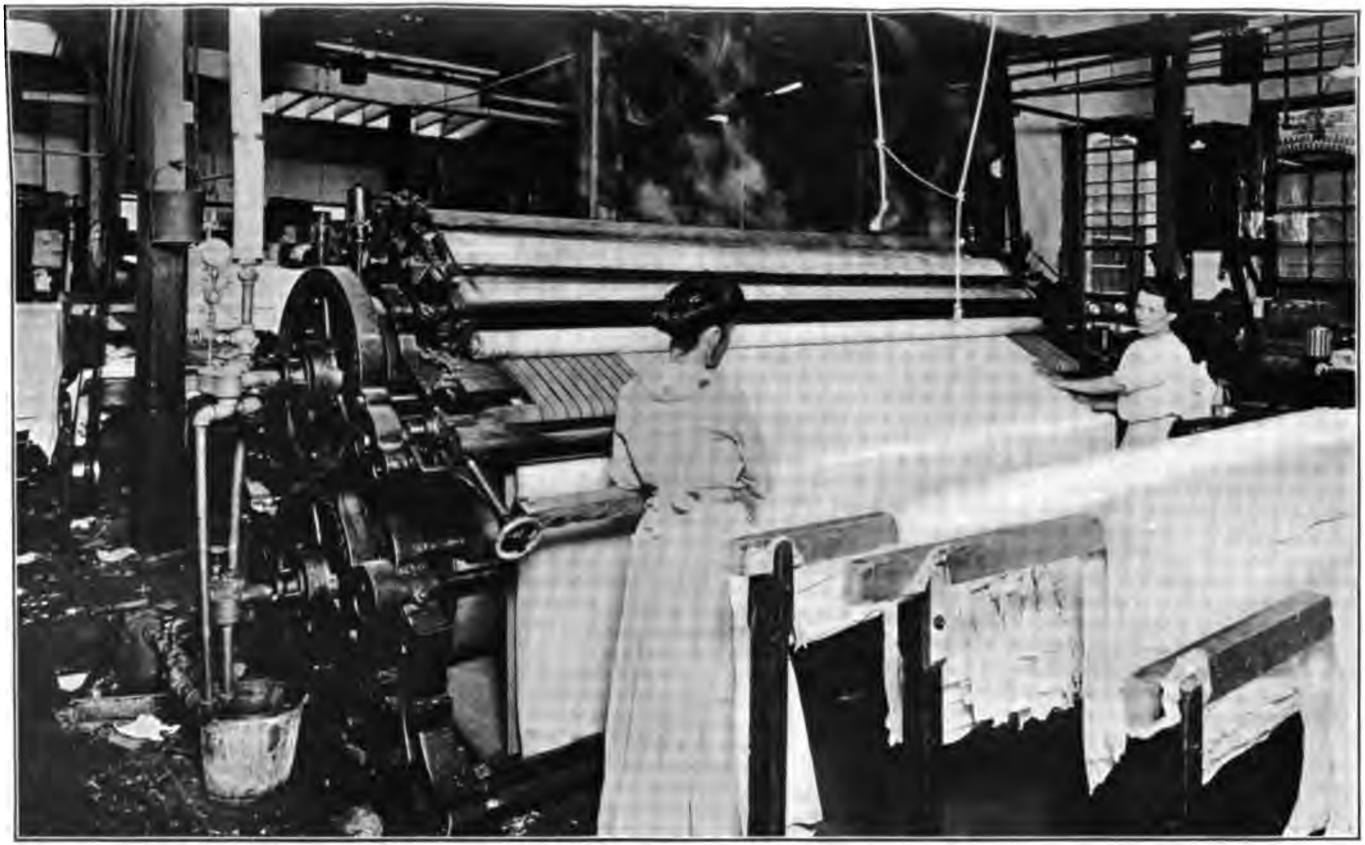
In finishing rooms or in other parts of laundries in which starched goods are ironed, a high temperature was the rule, due to the use of the heated irons. The air inhaled by women who work directly over gas-heated irons is apt to be vitiated by the products of combustion. In a number of laundries there was a noticeable escape of gas or gasolene from pipe connections or from rubber tubes connecting the pipes with the irons. The odor of illuminating gas was not uncommonly noted near ironing benches. The location of ironing benches and machines near windows made the heat more endurable in summer. In a few instances hoods were found over the rolls of body ironers, which greatly aided in the removal of superheated air from the faces of those who worked on the machines.

No definite or conclusive data could be obtained relative to the frequency of colds and catarrhal conditions resulting from going from a hot, humid atmosphere into the cold, winter air. Some of the operatives stated that during the winter months they were hardly ever free from colds, while others who had been at the work for a number of years



Effective protection against excessive steam and humidity.

UNIV. OF MICH.



Ineffective protection against excessive steam and humidity.

stated that they were not troubled by colds. Aside from the predisposition to colds, it can hardly be questioned that working for many hours of every day in a hot, humid atmosphere, with the consequent disturbance of the temperature equilibrium of the body, must interfere with the metabolic processes of the body and have an injurious effect upon the organism. While the majority of the employees appeared healthy and contented, some of the women looked pale and poorly nourished. About 50 per cent. of those who worked over gas-heated irons complained of frequent headaches.

GENERAL SANITARY CONDITIONS.

The sanitary conditions in laundries varied, as in most industrial establishments. Many were model plants in every respect. In the majority the conditions were at least reasonably good; some were moderately bad in one or more particulars; a few were distinctly bad.

Light. — The processes of laundry work do not require very sharp vision. In order that those who iron may turn out satisfactory work they must have reasonably good light, and so they usually work near windows. In some small, basement wash rooms the light was moderately poor, — in a few so poor that constant artificial light was necessary, — but in the great majority of laundries the light was at least fairly good, and in many instances it was excellent. A few laundries, on account of their location, with high buildings on either side, could not get a desirable amount of daylight and had to depend upon artificial light on dark days or in the latter part of the afternoon. The placing of flat-work ironers in the center of the room in some instances rendered natural light insufficient. In no instance was the light deemed to be so poor that the sight of a worker was endangered thereby.

Cleanliness. — In wet-wash laundries using old buildings, in some instances unsuitable for other purposes, the standard of cleanliness was often observed to be poor; walls and floors were often dirty, and there was a generally prevailing disorder. On the other hand, in steam laundries, with very few exceptions cleanliness was at least reasonably satisfactory, and a number were found scrupulously clean. Practically no spitting upon floors was observed, and in some laundries instant dismissal was the penalty for such spitting. While a certain amount of wet and sloppy conditions is unavoidable in the wash rooms, there are no processes in laundry work which can be called dirty.

Ventilation. — Ventilation in laundries depended considerably on the type of building in use, the arrangement and height of the rooms and the presence or absence of ventilating stacks, roof ventilators, hoods, suction pipes, blowers, electric fans or similar ventilating appliances. In buildings not adapted to the purposes of the trade ventilation was not so good as in those built especially for the purpose. In some steam laundries which conducted all processes of the industry in one room or in two connecting rooms the heat, humidity and products of combustion from washing machines, flat-work ironers and other ironing machines produced a condition of poor ventilation. As a rule, however, the ventilation was found fairly good, and in a number of laundries it was excellent, even in the wash rooms. Orders were issued in a number of instances requesting proper ventilation. These orders were complied with by the installation of fans or by the better use of ventilating facilities already installed.

Toilet Facilities. — As in all industrial establishments, the sanitary conditions of the water-closets provided for the use of men and women varied from excellent to bad. There appears to be no excuse for dirty water-closets in the laundry business.

In a few laundries lunch rooms for the use of the employees were provided.

Tuberculosis in Laundry Workers. — Careful inquiries were made into the prevalence of tuberculosis among laundry workers, but there was no evidence to show that the disease was unusually prevalent among them. Indeed, the results of the inquiry rather tended in the opposite direction. For example, among all tuberculosis cases reported to the boards of health of Clinton and Fitchburg during a term of five years prior to this investigation none occurred in a laundry worker, although there are several laundries of good size in these places.

CONCLUSIONS.

1. Laundry workers, of whom four-fifths are females, are exposed to —

(*a*) The inherent danger from contact with the infectious material of soiled clothes. While no cases of such diseases so contracted were found, and the danger is believed to be very small it may be still further decreased by co-operation between boards of health and proprietors of laundries, whereby the latter may receive notification of cases of contagious diseases on their routes.

(*b*) Overheat and excessive humidity created by the processes of the industry. It is possible and practical, in a large measure, to overcome these unhygienic conditions by the use of proper ventilating appliances.

(*c*) General fatigue and ill effects consequent to prolonged standing, necessitated by the nature of the work.

2. The general sanitary conditions were in the great majority of laundries at least reasonably good.

3. Tuberculosis was not found to be unusually prevalent among laundry workers.

EXAMPLES OF GOOD AND BAD LAUNDRIES.

The following are selected from among the laundries visited as examples of good and bad laundries: —

EXAMPLE A.

This is a combined steam and wet-wash laundry which employs 75 people, of whom 60 are females and 15 are males. Of the female employees, 7 are less than eighteen years of age.

The building is of brick, modern construction, three stories and a basement, and was constructed for the purpose.

Basement. — Here is the wash room. It is high, well lighted and clean. The floors are of cement, and drainers under the washing machines take away the water, so that it is not necessary for the workers to stand on wet floors. The ventilation is excellent and is maintained by windows, by ventilating stacks and by two 36-inch fans revolving 800 times each minute. No noticeable amount of steam is in the room, it is not unduly hot, the walls are white, and in all respects the conditions are worthy of special commendation. Excellent water-closets are provided for both sexes.

First, Second and Third Floors. — Sorting soiled linen, bundling it for the wash room, marking, starching by machines, ironing by flat-work ironers, hand or by machine irons, sewing on buttons, darning, repairing rents, drying in dry rooms, resorting, checking and bundling for delivery are done in various portions of these three floors. All are very high, the walls well whitened and the floors scrupulously clean, the light in all parts excellent, and ventilation adequate. A fan revolving in a window near the flat-work ironer aids in removing the steam created by that machine. The rooms are neither overheated nor excessively humid. Water-closet conditions are excellent. The machinery is carefully safeguarded, in the interests of the employees, against accidents. First-aid outfits are provided. A person detected spitting upon the floor is instantly discharged from the employ of the firm.

EXAMPLE B.

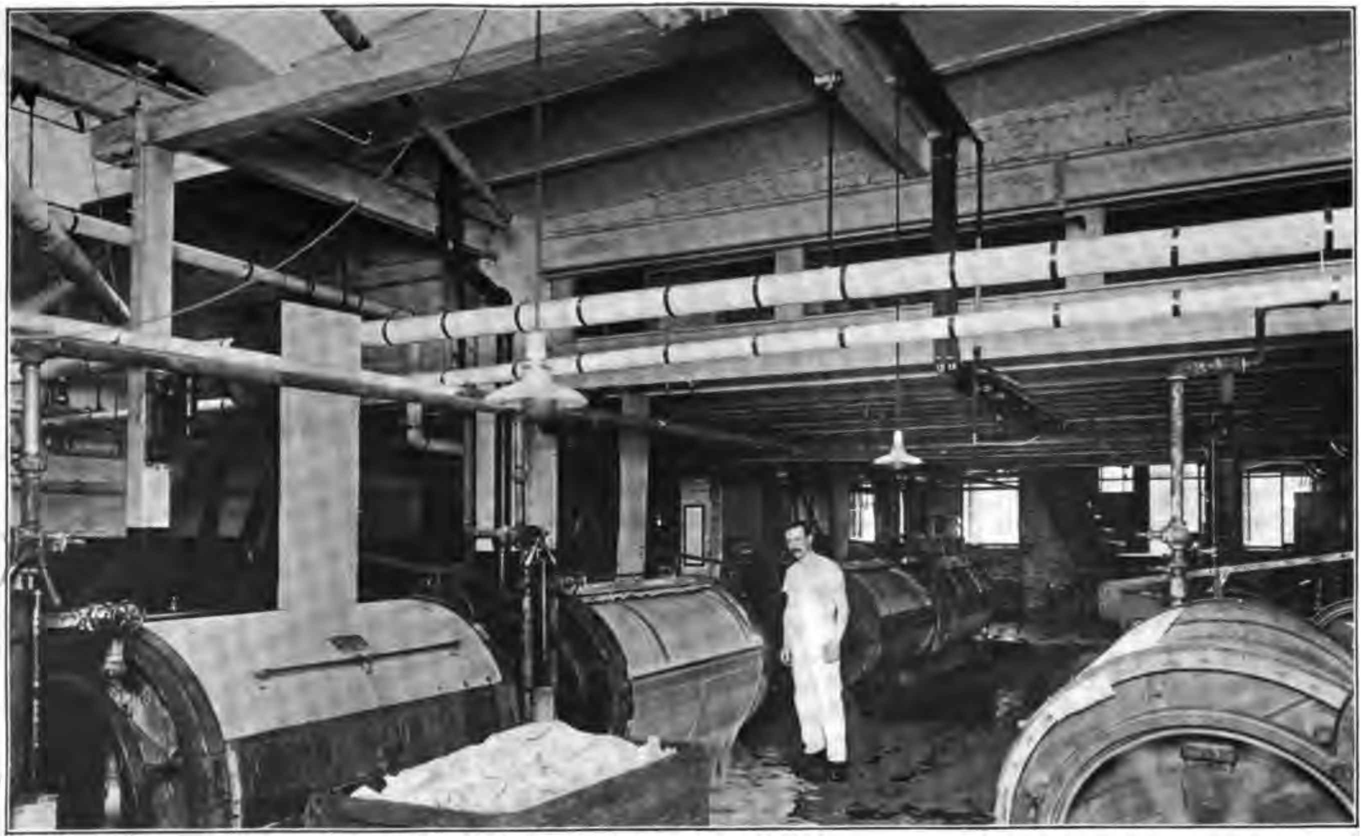
This is a steam laundry. No wet wash is done here. It employs 19 persons, of whom 16 are females and 3 males. Two of the females are less than eighteen years of age.

The first or street floor of a two-story, wooden building, quite old and originally built for mercantile purposes, is used by this concern. The whole working space is practically one large room. The front or street part is used as a sorting and bundling room and for such work as is done on body ironers, collar, cuff and bosom ironers. This part is badly overcrowded by machines and boxes. The light is from the front only, so that in portions it is moderately bad; the room is overheated by ironing machines, and the ventilation is inadequate because there are no transoms in the windows and the ventilation is entirely by the doors in the winter season. The room here is cluttered and uncleanly. The room is low.

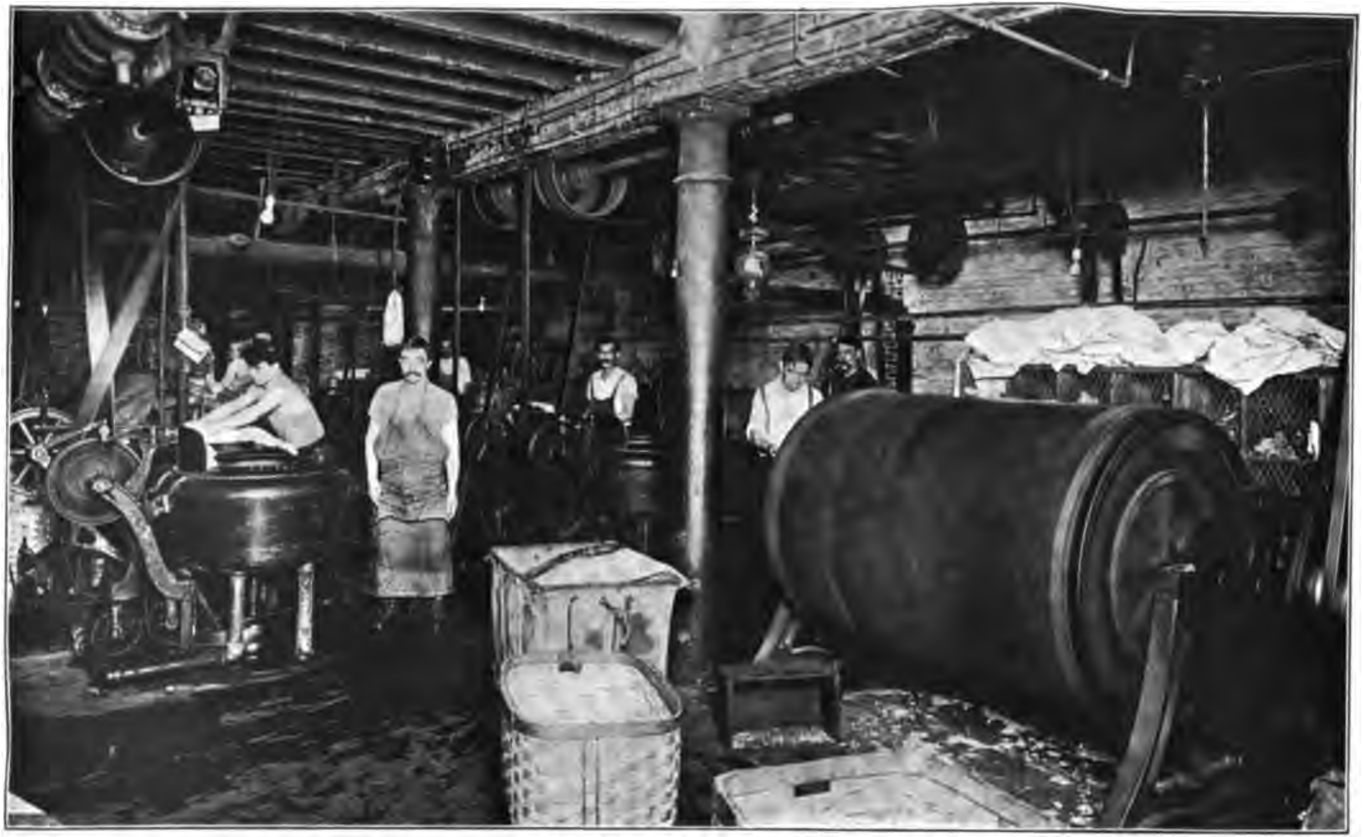
The rear portion of the room is used as a wash room, and in it is a flat-work ironer, placed in the center of the room, where the light and ventilation are the worst. There is no light from either side; in portions it is distinctly bad, so that two women working upon a starching machine are obliged to work by electric light. Ventilation is inadequate; the room is very hot and excessively humid. The two female minors work on the flat-work ironer in the center of the room, where all conditions are at their worst. This portion of the room is also overcrowded. Water-closets are placed in dark corners and ventilate directly into the work room. Several of the women operators were pale and languid. The unsuitableness of the building was largely responsible for the bad conditions.

ATTITUDE OF MASSACHUSETTS MANUFACTURERS TOWARD THE HEALTH OF THEIR EMPLOYEES.

The State Inspectors of Health, under the supervision of the State Board of Health — a supervision which is based upon broad, general principles — have, among other duties, charge of the health inspection of industrial establishments. Consequently, they have had opportunity to observe the attitude of manufacturers to their employees and to the laws of the Commonwealth which safeguard the health of the employees. From the data thus collected, manufacturers may be classified in two general groups. There are, on the one hand, those who concern themselves but little with the health and welfare of their employees, men who regard all protective legislation as unnecessary interference on the part of the State with private enterprise. To this class belong, in the main, the smaller industrial establishments which need considerable looking after in order that they may be kept in reasonably good sanitary condition. Many owners, or men in charge of such establishments, comply with the laws unwillingly, if, indeed, they do not oppose their enforcement. Only such changes are introduced in the buildings as are absolutely necessary, and no attempt is made to see that the changes bring the most fruitful results. In this class of establishments one finds an atmosphere of distrust between employer and employee. The prevailing idea is that their interests are divergent. The employer regards any outlay of expense to improve conditions under which his employees work as an unjust burden placed upon him by the State. The employee, on the other hand, regards any attempt to change conditions with considerable suspicion. Fortunately, however, this class of industrial establishments is rapidly diminishing in number and such a state of affairs as mentioned is fast disappearing.



Model laundry workroom.



Laundry workroom, showing distinctly bad sanitary conditions.

The second class of manufacturers represents principally the larger industrial establishments. These owners of the larger, and the more progressive owners of the smaller establishments, recognize the fact that their interests are identical with those of their employees, from a purely economic standpoint. These employers recognize that money invested for the maintenance of sanitary and healthful conditions in their establishments is a profitable investment. They also recognize that aside from all humanitarian motives the expense of maintaining good sanitary conditions increases the efficiency of their employees. In this class of establishments one finds a readiness and willingness on the part of the employers to comply with the laws of the Commonwealth. Indeed, suggestions from the State Inspectors of Health as to how to improve conditions are often sought for. Compliance with the laws is not carried out in a perfunctory manner. On the contrary, care is taken that all improvements are utilized in such a way as to secure the best working conditions possible. In short, the manufacturers realize that good working conditions result in obtaining better, more intelligent, and steadier employees. They realize, further, that absences on account of sickness are diminished and a higher grade of efficiency is secured.

STATEMENTS OF MANUFACTURERS RESPECTING SANITARY CONDITIONS AND FINANCIAL AID TO EMPLOYEES.

"We have shops in which the sanitary conditions are a source of pride to us. They are clean, well kept, well lighted, and the help are safeguarded against any unhealthy influence. We do not allow any spitting on the floors. . . . The efficiency of our employees depends upon their good health and we recognize the fact."

"While we render no financial aid to those ill, we do try to keep the condition under which our men work as good as we can, and we keep a special oversight of our young apprentices, realizing that upon them we shall later depend for our skilled work. Our doctor examines apprentice boys before the company makes out their first papers, and during the time of their apprenticeship they are under the constant supervision of their instructor, who notifies their parents whenever any of them appear to be ill or below physical par."

"Make the conditions in the mills right and the mill conditions will not make employees sick and in need of aid."

"We intend to keep on bettering mill conditions and have just installed a humidifying apparatus at a cost of about $20,000."

As to the policy of firms in regard to helping financially, to any extent, an employee taken ill while in their employ with any disease, opinions of representative manufacturers throughout the State are as follows: —

"We have helped employees who have been ill by contributing to a subscription taken up among the employees. This was done for one man ill with typhoid fever and enabled him to pay hospital bills and to keep his family from want for a period of eight weeks. A similar subscription was taken for a man suffering from kidney disease. . . ."

"Formerly we occasionally helped out an employee who was sick, but a few years ago two benefit societies were organized among the help. The only part we play now is to take the monthly assessments from the pay envelopes at the request of the officers of the societies. Sometimes, in the spring of the year, when a good many are out with colds and extra assessments would have to be made, the company assists enough to fill a deficit or to prevent another assessment, but the company has no voice in their management."

"There is no fixed plan or system. Have been accustomed to give assistance in deserving cases, each case being considered individually. In one case a hospital bill was paid and in another rent was given, etc. . . . No discrimination is made in reference to tuberculosis."

"We do nothing financially for those who may become ill from any cause, our care being strictly limited to accidents."

"The firm has not helped in case of illness, tubercular or otherwise, but we have often helped financially in cases of accidents in our shops, even though we carry liability insurance. It not uncommonly happens that an injured man draws his pay while away from his work."

"While we have no settled policy in the matter, this company has helped financially, and probably will continue to do so, its employees who become ill while in their employ, although such cases are selected cases, so to speak; that is to say, it is not done in all cases. We have now on our pay roll a girl ill with tuberculosis, whose expenses are paid by us. I mean that we allow her full wages. She is not in a sanatorium, however, and pays her own bills. She has not worked for some weeks."

"We pension old and faithful employees. . . . One employee has been drawing full pay for the last five years. In case of accident we assume the entire expense of the case and sometimes pay full wages besides, although this does not mean that we assume liability for the accidents. We are willing to help our employees, and that applies as much to tuberculosis as to anything else."

"The company has no special plan for assisting employees who are ill. A workman who had been employed for less than two years would probably receive no assistance. An older workman would be looked up and such assistance as necessary rendered. Each case is regarded as a personal matter, and the fact that aid is given is not advertised."

Thus a large number of firms, while not having a settled policy in the matter of aiding their employees in case of illness, frequently do so. It is the general opinion of manufacturers, however, that cases of illness among their employees, if dealt with at all, should be dealt with individually, the amount of aid depending on the length and quality of service rendered by the individual. Often old employees who have given faithful service for many years, though the amount of work they do does not warrant it, still receive full pay. Another way in which manufacturers aid their employees is by assisting them to organize and maintain mutual-benefit associations and by contributing generously to the funds of such organizations.

SPECIAL HEALTH AND WELFARE WORK.

But besides the attitude taken by manufacturers, who believe that it would be poor policy to assume any financial obligation in case of the illness of an employee, steps have been taken by many manufacturers on their own initiative to promote the health and welfare of their employees. There are various directions in which this activity is manifested; for instance, in the maintenance of attendants or of trained nurses and in the employment of a physician who is either on the premises all the time or who makes periodic visits and is called whenever needed. Nor is the interest of the manufacturer in every instance confined to the factory. Some companies have trained nurses who not only supervise the employees at their work, but visit their homes and do a great deal of educational work. A considerable number of firms are now contemplating the employment of trained nurses for similar work. One company, employing from 2,000 to 3,000 men, women and children, obtained information during the year ending April, 1910, — with the assistance of two trained nurses and a physician, — concerning the health of 2,296 employees, of which number 1,011 were males and 1,285 were females. Two hundred and forty-four cases of illness were of a surgical nature. Ten employees were found to be ill with tuberculosis and were provided for at the State sanatorium at Rutland. With one exception their condition appears to be favorable for recovery. Two have already returned to work, and some of the others have left the sanatorium with the disease arrested. When an employee returns from Rutland he is under observation; his home is visited and such help is given as is practicable in order that he may hold the gain made at the sanatorium. The nurses and physician also discovered a number of boys and girls who appeared to be in danger of respiratory disease, such as influenza or tuberculosis, and in each instance instructions in hygiene were given and the health of the children followed up until normal health was restored and efficient work accomplished. Such special attention is given to employees under eighteen years of age. While generally these young persons are found to be in good physical condition, the teeth and the tonsils in many cases are found to need attention. The ventilation of the workrooms is studied, and, whenever necessary, changes are made which in some instances have given rise to a marked improvement in the output of the pieceworkers and in the energy and effort of the time-workers.

Another striking example of the attitude taken by a manufacturing company toward sickness among its operatives is the following: the company maintains an accident and retiring room in charge of a trained nurse, who, in addition to giving first aid, attends to minor medical cases and visits sick operatives in their homes to insure proper medical attention and care. During the year 1910 more than 1,600 such visits were made. In rendering financial aid to operatives in the past it has been the custom to consider cases individually. Sometimes the wages are paid, sometimes hospital bills, in some cases both. The company maintains 4 free beds at the local hospital. In regard to tuberculosis, the nurse has devoted special attention to investigating the prevalence of this disease during the past two years. In 1910 about 30 cases were cared for, and at the present time 5 are under treatment. In some instances the company pays the bills or part of them, but all patients, through the nurse, are given proper care. It has been customary to turn the chronic cases over to the State or to the local tuberculosis society or to find suitable homes for them in the country. There is a mutual-benefit association with voluntary membership, costing an employee 25 cents per month. Although it is managed by the operatives, the company frequently contributes to its success. This company neither advertises nor conceals the fact that operatives may receive financial aid from the firm in case of sickness and does not object to having it known.

The above examples well illustrate the rapidly growing tendency among Massachusetts manufacturers of recognizing the fact that the maintenance of good sanitary conditions in the factories and activities tending to preserve the health of the operatives increases their efficiency, and that all money expended in such activities brings returns which can be measured in dollars and cents.

HYGIENE OF THE BOOT AND SHOE INDUSTRY.

There is in preparation a report on the general sanitary conditions observed in boot and shoe factories, including a description of a practical method of obtaining dust records in dusty processes, and its application to the operatives' protection. The report will be issued as a separate document some time during the coming year.

STATISTICS RELATIVE TO THE HEALTH INSPECTION OF FACTORIES AND WORKSHOPS.

In the fourth annual report on the work of the State Inspectors of Health a statement was made that this year's report would contain a complete record of the number of inspections made in industrial establishments, the number of orders issued and the number complied with during the year. Accompanying the statement was the following important explanation: —

> In the enforcement of the laws relating to the sanitation of factories and workshops, the State Inspectors of Health have aimed to do thorough work, even though this involved visiting a smaller number of establishments than otherwise might be visited. It must be borne in mind that the chief value of the service to persons who work in industrial establishments, and to the community, does not lie in routine or systematic inspection, but in the changes which give rise to better sanitary conditions, and in the introduction of methods to protect more efficiently the health of the workers from injurious influences. In fact, the essential purpose of inspecting the sanitary conditions in industrial establishments is to safeguard the health, first, of the workers, and second, of the community at large. It has been the custom of the inspectors to make a careful study of all the influences in a given establishment which may be injurious to the health of the workers. Such a study has involved a knowledge of the sanitary conditions, including the adequacy of light, ventilation and cleanliness of the establishment, as well as some knowledge of the various industrial processes in which the operatives were engaged. This work in every instance has led to practical results; if any unsanitary conditions were found, if any processes were conducted wherein employees were exposed to injurious influences, orders were issued, and, if no specific statute covered the case, recommendations were made to provide for the necessary changes.

The report of the Commission to investigate the Inspection of Factories, Workshops, Mercantile Establishments and Other Buildings, submitted to the Legislature in January, 1911, says on page 14: —

> As to the health inspection now carried on under the State Board of Health, the commission finds that the work is good so far as it goes. But the scope of this inspection is at present very limited.

Again, on page 74: —

> The members of the commission recognize that the work of health inspection in manufacturing and mercantile establishments has been efficiently organized and directed under the State Board of Health, and that valuable results have already been achieved in this field.

Again, on page 37: —

> It is the policy of the Board to encourage intensive work in the part of the field actually covered rather than to attempt to cover the entire field in a superficial and ineffectual fashion.

In considering the scope of the inspection of industrial establishments by the State Inspectors of Health, it must be remembered that the amount of time that can be given to this work is limited in two ways: first, by a very limited appropriation for salaries and expenses, and, second, by the numerous other powers and duties conferred and imposed upon the State Inspectors of Health by the Legislature.

The State Inspectors of Health have made an effort to inspect industrial establishments in a thorough and systematic manner. Every recorded inspection of an industrial establishment meant a complete investigation of all the sanitary conditions in that establishment, an investigation of all the processes carried on, and their possible effects on the health of the operatives, more particularly on minors who may be engaged in processes injurious to their health. To make such inspection of some of the large industrial establishments in the State, some of them occupying a great number of buildings and employing 5,000 or 6,000 employees, is not a matter of a few hours but is a matter of days, and, including the examination of minors, may take a week or more.

In every establishment visited efforts have been directed to raise its sanitary standard to what was found in the best establishments carrying on similar work under similar conditions. It was thus often found necessary to make a great many inspections of some establishments until the desired results were brought about. This, of course, consumed a great deal of time, but the results achieved, which could not be achieved by a superficial inspection, justified the time spent. All orders issued or suggestions and recommendations made were followed up until such changes were made as were satisfactory to the State Inspector of Health and the State Board of Health.

Statistics of Factory, Workshop and Mercantile Inspection Work throughout the State for the Fiscal Year ending Oct. 31, 1911.

Number of inspections made of factories, workshops, and mercantile establishments,	2,688
Number of factories, workshops and mercantile establishments inspected,	1,921
Number of factories, workshops and mercantile establishments in which orders were issued,	448
Number of factories, workshops and mercantile establishments in which no orders were issued,	1,473

Of the 2,688 inspections made —

670 establishments were visited for the first time.
490 establishments were visited for the second time.
527 establishments were visited for the third time.
481 establishments were visited for the fourth time.
247 establishments were visited for the fifth time.
124 establishments were visited for the sixth time.
68 establishments were visited for the seventh time.
34 establishments were visited for the eighth time.
19 establishments were visited for the ninth time.
12 establishments were visited for the tenth time.
6 establishments were visited for the eleventh time.
3 establishments were visited for the twelfth time.
3 establishments were visited for the thirteenth time.
2 establishments were visited for the fourteenth time.
1 establishment was visited for the fifteenth time.
1 establishment was visited for the sixteenth time.

Orders were issued and complied with as follows: —

	Issued.	Complied with.
Cleanliness,	63	46
Light,	66	28
Ventilation,	59	39
Removal of dust,	151	80
Artificial moisture,	11	7
Drinking water supply,	17	13
Women's seats,	12	11
Water-closets, including toilet rooms in foundries,	297	190
Washing facilities in foundries,	8	6
Health of minors (chapter 404, Acts of 1910),	15	12
	699	432

Of the 267 orders not complied with many are in progress of compliance, while others are being followed closely by the State Inspectors of Health.

Notices were issued in regard to —

Receptacles for spitting,	99
First-aid outfit,	126
Defective sanitary arrangements,	2
	227

HEALTH OF MINORS IN FACTORIES.

Number of Minors seen and questioned.

	AGE.			
	14	15	16	17
Number,	2,892	3,918	5,196	5,331

Number of physical examinations made because of —

Tubercular family history,	166
Previous personal history,	110
A pale skin,	64
Special trades or processes,	26

The total number of minors, so far as could be determined, judged to be in ill health, were: —

Males,	193
Females,	125

Classification of Conditions of Ill Health, Physical Unfitness or Abnormalities.

Anæmia and malnutrition,	114
Chlorosis,	2
Tuberculosis or pre-tubercular conditions,	24
Cardiac disease,	21
Bronchitis,	5
Laryngitis,	1
Adenoids and hypertrophied tonsils,	49
Nasal polypi and other obstructions,	3
Other pathological conditions of the nose,	7
Diseases of the middle ear (chronic),	3
Trachoma,	1
Conjunctivitis,	4
Strabismus,	7
Other pathological conditions of eye,	10
Impetigo contagiosa,	1
Pediculosis,	1
Herpes (labial),	1
Other pathological conditions of skin,	8
Headache (cause not determined, probably due to eye strain),	11
Epilepsy,	3

Menstrual disturbances,	8
Bad teeth,	17
Facial deformities,	5
Deformities of chest,	6
Curvature of spine,	1
Septic finger,	1
Flat foot,	1
Defective speech,	2

HEALTH OF MINORS IN FACTORIES IN RELATION TO THE INDUSTRY.

In the course of the usual investigations concerning the health of all minors employed in factories and workshops, State Inspectors of Health observed, during the year, numerous conditions which appeared to possess elements of more or less danger to the health of minors subjected to them. Certain of these conditions were unavoidable and were created or necessitated by the industry, while, on the other hand, certain other poor conditions were deemed to be avoidable and unnecessary. Inasmuch as similar conditions were observed in other years and have been reported upon in previous annual reports of the State Inspectors of Health, they are not all mentioned here. The following instances appear to be worthy of notice: —

Exposure to Dust.

Pearl Working. — An examination was made of 7 factories in which pearl working was done, with especial reference to the employment of minors in the dusty processes of this industry. In 3 of these no minors were employed, while in the remaining 4, 13 minors, of whom 7 were males and 6 were females, were found. These worked at processes which created considerable amounts of pearl dust in spite of the mechanical appliances which were provided to remove this dust. Of these minors, 3 worked at polishing pearl, 1 at drilling, 3 at grinding, 2 at doming, 1 at cutting, 1 at carving and 2 at sawing. A letter was sent, after consultation with the State Board of Health, to each of the 4 proprietors who employed minors, calling attention to the fact that such work by minors was contrary to section II of the schedule prepared by the State Board of Health in accordance with the provisions of chapter 404 of the Acts of 1910, relating to the employment of minors in processes deemed to be injurious to health, and their exclusion therefrom.

At a subsequent visit within one month of the date of sending this letter it was found that all of the minors had been taken from the dusty processes.

Manufacture of Curled Hair. — Three girls worked at the very dusty process of sorting screenings and floor sweepings. The dust was unavoidable and the girls were observed to cough considerably, although examinations were negative. The dust was composed of small hairs and floor dirt.

Manufacture of Stove Linings. — In this industry, in which stove linings and fire brick are made, were found two boys who were exposed, unnecessarily, to very large amounts of dust created by the operation of grinding up old and imperfect linings and bricks. The dust was clay dust entirely. Although the work was carried on in a small shed and the boys were only intermittently exposed to it, upon the request of the State Inspector of Health mechanical appliances for the removal of the dust were installed by the proprietor who was much pleased with their efficiency.

Manufacture of Cotton Machinery. — A boy was found engaged in hand-filing grooves on metallic rolls. He was obliged to assume a cramped position, the dust of the filings covered his face, and undoubtedly more or less of it was inhaled. The attention of the State Board of Health was called to this matter and subsequently this process was added by the Board to the list of processes from which minors are excluded from working, under the provisions of the statute above quoted. The proprietor of this factory excluded the minor from such work.

Exposure to Poisonous and Irritating Fumes and Gases.

Naphtha. — Four girls who worked in a workshop in which raincoats were made, applied naphtha cement to linings with their fingers by dipping them into the cement in open receptacles; it was claimed that it was necessary, to obtain the best results, to apply the cement in this manner, and if this was true the open receptacles became necessary also. Although the room was high, with plenty of windows which were open, and there was additional ventilation by overhead ventilators, the presence of naphtha fumes was distinctly and objectionably noticeable. All of the girls appeared well and none would acknowledge any discomfort from the naphtha. Owing to the nature of this work the girls stood all of their working time.

In the stitching room of a large shoe factory, 14 minors, of whom the majority were females, were exposed to objectionable amounts of naphtha fumes because of the use of open receptacles for naphtha cement, and as a result of a letter, sent after consultation with the State Board of Health, the proprietor took action which resulted in an improved use of the receptacles, this action being taken under the provisions of the chapter quoted above, relating to the exclusion of minors from dangerous processes. For commercial reasons, if for no other, the proprietors of shoe factories say, "It is to our interest to keep the loss by evaporation down to the lowest limit."

A group of minors working in a rubber factory were exposed to naphtha fumes. It was suggested to the proprietor that closed receptacles for the cement be provided. It was found on subsequent inspections that these had been installed, not only in the rooms in which minors worked, but also in departments where adults alone worked. In another factory of the rubber industry 80 minors were employed, of whom 28 were males and 52 females. Although the factory was splendidly ventilated, nearly all of the minors were exposed to varying amounts of naphtha fumes. Minors employed in the spreading rooms of this factory, in which it was impractical to provide adequate means for the removal of naphtha fumes, were excluded from these rooms. In the making up and coat rooms there was improper use of open cement receptacles. The firm was required to provide covers for the receptacles and to keep the latter covered when not actually in use. A number of the minors stated that when they commenced work in this factory they suffered from headaches and other symptoms of naphtha intoxication, but after a time experienced no apparent disturbance.

Nitric Acid. — The attention of an employer was called to the fact that a boy was exposed to the fumes of strong nitric acid. The minor was removed from the exposure to these fumes.

In a large chemical works it was found that a number of minors, working as pipe helpers, were exposed to the fumes of strong acids. Arrangements were made that they should be kept away from such work.

Acetate of Amyl. — In a factory in which art goods and picture frames were made was found a minor who worked at spraying acetate of amyl and bronze on picture frames. Although exposed to considerable of the fumes, he did not complain of the work; indeed, he was unusually robust. An efficient blower system aided in the removal of the fumes. This work was deemed to be dangerous to the health of the minor, and subsequently this process was included, by the State Board of Health, in the list of processes from which minors are to be excluded.

Exposure to Overheat.

Exposure of minors of both sexes to overheat was noted to be unavoidable in certain processes connected with the straw hat, woolen, fabric finishing and jewelry industries. A similar condition was noted in the glass-blowing industry, in which male minors were exposed to the extreme heat and glare at the mouths of the reheating furnaces in a large glass foundry.

Exposure to Metallic Poisons.

Lead. — In one health district the minors working in printing and lithographing establishments were carefully examined for signs of lead poisoning. They were talked to in a kindly manner, and it was explained to them why it was necessary for them to keep their hands away from their mouths and faces, also the importance of cleansing their hands and teeth before eating. The employers were instructed to use every reasonable precaution against poisoning, and to encourage minors in personal cleanliness. Wherever molten lead was found the proprietor was advised to keep the minors away from it and to properly hood the kettles. A second inspection of the minors was often quite gratifying in their improved personal appearance.

In a tile factory instructions were given by the State Inspector of Health to allow no minors to work in that part of the factory in which the tiles were glazed, an operation from which many cases of lead poisoning have developed.

In a printing office was found a boy helping to run a bronzing machine which was not equipped with a fan. The manager voluntarily took him from the work.

General Observations.

A State Inspector made the following statements with regard to minors working in factories as observed in his district, in which the industries are widely diversified: —

1. Very few minors were employed.
2. Without exception the minors worked under satisfactory sanitary conditions.
3. Those minors employed were, as a rule, in good physical condition.

The reasons for the above facts were found to be as follows: —

1. Certain industries, as, for example, the hat industry, for economic reasons employ few, if any, minors. Other industries, such as iron and steel, *i.e.*, cotton machinery, machine tools, foundries, etc., employ practically no minors because the work is either too heavy or requires skilled labor.
2. The home conditions of the minors were, as a rule, satisfactory. Many lived in comfortable homes in country towns or villages with their parents. Few lived in tenement blocks.
3. The officers who hire the operatives will not take on minors who appear to be in poor health.

This statement accounts for a group of "selected" minors working and living under satisfactory conditions. It does not account for a class of minors who have left school and the supervision of the school physician, but who have been refused employment at factories because of more or less obvious physical unfitness. In this latter class undoubtedly there must be a mass of tuberculous material entirely without supervision.

Visits to factories that happened to coincide with visits of minor applicants for work showed that superintendents and foremen who hire the operatives, as a rule, will say to an undersized minor or one of doubtful physical condition, that there is no work for him. If, on the other hand, the minor appears healthy the foreman will take his name and address and send for him when a vacancy occurs.

It is of importance to account for this unsupervised class because, in the first place, it is at the age where tactful supervision will give the best results and, in the second place, it will, through them, bring State Inspectors of Health in contact with other members of their families, possibly in the same condition.

By the following method an attempt is being made in this health district to obtain the names and addresses of as many of this class as possible: the officer whose duty it is to hire operatives under eighteen years of age is asked to give to the State Inspector of Health the names and addresses of all minors whom he rejects for physical unfitness. As these minors often apply to several factories, several chances are given that the Inspector will be notified.

The minor may then be visited at his home by the State Inspector of Health, and in this way be given proper medical supervision, directly, through the family physician, district nurse, social worker, or other suitable agency.

In a number of instances State Inspectors of Health have given assistance to school physicians who are now required by law to certify that minors are physically fit to perform the work for which they apply to factories. It was learned that at least in one instance a minor who was pronounced physically able to do certain work by a school physician, after working at that process for two weeks was put at work at a much harder process, so hard that it is not believed that the school physician would have given his consent to such work on the part of this particular minor.

INSPECTION OF MERCANTILE ESTABLISHMENTS.

Visits to mercantile establishments were made, as a rule, only on complaint that violations of the law existed on the premises. The need of a law requiring adequate ventilation in mercantile establishments became manifest during the inspections. The ventilation of many of these establishments was found to be inadequate. This was especially true of the so-called "bargain basements" of the large mercantile houses.

HYGIENE OF TENEMENT WORKROOMS.

The general methods of inspecting and licensing tenement workrooms, and guarding the public health against infectious diseases which might be spread by means of contaminated wearing apparel, has been described in detail in previous reports. The feature in connection with this work which deserves mention is the employment of women assistants in Suffolk County to inspect and license the tenement house workers under the direction of the State Inspector of Health of that district.

Early in the work it became apparent that besides the primary object of guarding the public health against the spread of contagious diseases from the tenement workrooms there was a great field for educational work among the inhabitants of the congested districts to bring about higher standards of hygienic living. It was felt, however, that inasmuch as the home workers were women, friendly contact with women inspectors would lead to more efficient results. The service of an active, intelligent, young woman was first obtained. She now has full charge of visiting the tenement workrooms and coming in friendly contact with the workers. To sketch briefly the methods of inspection and supervision of this worker may be worth while.

All applications for licenses to work on wearing apparel at home are received at the office of the State Inspector of Health. These are turned over to the woman assistant, who visits the premises to determine the number of rooms occupied by the family, the number of inmates and the sanitary conditions of the premises, such as the cleanliness of the rooms, particularly of the room where the work is to be done. The condition of the health of the inmates is ascertained, inquiries are made as to the existence of any communicable diseases, either among the members of the family applying for a license or among any of the families in the building. If all the conditions are satisfactory a license is issued. At the time of issuing the license the women of the family are instructed that cleanly conditions of the premises must be maintained at all times, and that the license must be promptly returned if any contagious diseases should occur in the family holding the license or among any of the occupants of the building. Among Italian families the personal instruction is supplemented by a circular, printed in Italian, which contains instructions relative to the proper sanitation of the home. If at any time objectionable conditions are found on the premises, or ill health among the members of the family, which raise a question as to whether or not a license ought to be issued in the given case, the matter is referred to the State Inspector of Health, who makes a visit to the premises to decide whether unhealthful conditions exist.

A record of each tenement workroom, giving a detailed statement of the sanitary conditions, and also the number of the license issued, or if the license is refused stating the reason for such refusal, is filed at the office of the State Inspector of Health. A street card index of all tenement workrooms is also on file, so that at a glance all the licensed tenement workrooms in any street or in any house in the district can be readily had. This street card index is especially useful in checking off the cases of communicable diseases, that occur in the district.

The local boards of health submit daily lists of diseases dangerous to public health which are reported to them. These are checked off on the street index of the tenement workrooms. If a contagious disease is reported from a building where a tenement workroom is located, the premises are visited not by the woman assistant but by the State Inspector of Health himself, and if public safety requires it the license is revoked and all work on the premises is stopped. In case any article of wearing apparel is found to have been in contact with infectious material these articles are retained on the premises, and the local board of health is notified to take such action as the public safety may require.

The tenement workrooms in the congested districts are inspected frequently in order to maintain good sanitary conditions. If it appears that the premises are not maintained in proper sanitary conditions, as is frequently apt to be the case when a visit of the inspector is not expected, the license is revoked.

The frequent friendly visits by the woman assistant to the homes in the congested district, and the friendly advice given by her to the holders of licenses, resulted in raising the general standard of sanitation of these homes. The conditions prevailing in the homes where licenses are held are far better than those found to exist in similar homes where no work is done, and which are consequently not subject to inspection.

The services of the woman assistant proved so valuable in the work that a second assistant was obtained.

We thus have, disseminated throughout the congested districts, many homes which are frequently inspected by friendly visitors, where conditions are maintained at a higher standard than would otherwise prevail. These cleaner houses have a good educational effect on the other tenants in the neighborhood.

Special efforts were directed during the year to locate all industrial establishments sending out work which would come under the statute provisions. This was done by inquiry from the workers, also by watching the advertisements in the press, where firms advertise for home workers. It was thus learned that some of the fashionable dressmaking establishments often send some of their work to dwelling houses. Many neckwear establishments were also found which sent work out to the homes without requiring licenses from the workers. All these firms were notified of the law, a complete registration was made of their workers, and work is not given out now by these firms without licenses.

Attention was called in previous reports to a variety of industries, the extent of which could not be determined, which are carried on in homes and for which no license is at present required, for the law provides only for the licensing of places where work is done on wearing apparel. Among the industries carried on in tenement houses were home laundering and the manufacture of lace curtains, mesh bags, paper boxes, artificial flowers, baseballs, cigars and cigarettes. Another curious industry was observed in a tenement house which should be added to the above list, — the making of "skewers and frills" used in high-class restaurants for the decoration of mutton chops served to the patrons. It is certain that if the patrons of these restaurants could see the conditions under which these ornaments were produced they would prefer to dispense with the ornamentation of meats served to them.

The question as to the advisability of doing away entirely with the working on wearing apparel in tenement houses is rather a complex one and cannot be settled from the standpoint of public health alone. There are many economic factors which must be taken into consideration, such as the effects on certain industries by such prohibition, the earning capacity of home workers, the effect of such home work on the earning capacity of the shop workers, and, above all, as to the likelihood or the possibility of enforcing such a prohibition.

As matters stand now perhaps more than half of the holders of licenses in the State are fairly comfortably situated and carry on the work in homes where the sanitary conditions are beyond reproach. The women who do the work, consisting mainly of crocheting on ladies' underwear, embroidery on waists, etc., work at ridiculously low prices, and do it either as a pastime or for the small amount of pin money. No special hardship would be incurred by these workers if such work were prohibited. On the other hand, it might induce many of the workers to spend their time more profitably. When a woman comes to the office of the State Inspector of Health, for instance, accompanied by her maid and pet dog, to ask for a license to do sewing on aprons for which she receives twenty-five cents a dozen, the work to be done in a comfortable single family house in the suburbs, — such a worker would in all probability not suffer by being deprived of this source of revenue, but the house would undoubtedly benefit by the additional attention which the mother might give to her four young children. There are, on the other hand, many Armenian women engaged in this work whose earnings, however small, help to increase the meagre family income.

The problem is somewhat different when we consider the workers in the congested tenement district. Prohibition of home work would, in many instances, mean considerable hardship for many families whose meagre incomes are increased by the earnings of the women, who are engaged in finishing men's trousers. The work which these women take home enables them to attend to their housework and look after the children, — duties which prevent them from going to work in the shops.

It must also be considered that the enforcement of prohibiting home work would be a matter of extreme difficulty and might result in the work being done in homes not subject to any inspection, under conditions far worse than are prevalent now in the tenement workrooms.

Numerical Data for All Districts.

Total number of visits to tenement workrooms,	4,407
Number of licenses granted,	2,413
Number of licenses refused,	122
Number of licenses revoked,	413

Of the 413 licenses revoked, 60 were revoked on account of contagious diseases that occurred among the families of the tenement workers.

Numerical Data, Suffolk County.

Total number of visits to tenement workrooms,	3,100
Number of licenses granted,	1,277
Number of licenses refused,	98
Number of licenses revoked,	402
Number not found,	395

Of the licenses revoked 49 were revoked on account of contagious diseases in the family as follows: —

Scarlet fever,	30
Diphtheria,	11
Tuberculosis,	2
Measles,	3
Chicken-pox,	1

Two cases of impetigo contagiosa were found in the course of inspection, and the licenses were revoked.

SANITATION OF STATION HOUSES.

In accordance with chapter 405 of the Acts of 1910 the State Inspectors of Health made the second annual examination of police station houses, lock-ups and houses of detention, and in accordance with chapter 282 of the Acts of 1911 the first annual examination (excluding Suffolk County) of houses of correction, prisons and reformatories. Following the provisions of chapter 405 of the Acts of 1910 the State Board of Health have prescribed the following general rules concerning police station houses, lock-ups and houses of detention: —

1. *As to furnishing and Use of Drinking Cups.* — The provision of the common drinking cup is unlawful in accordance with the provisions of chapter 428 of the Acts of 1910. A drinking cup after use by one person should be washed clean before being used by another.
2. *As to Dishes used for Food.* — All dishes and utensils used for food should be thoroughly cleaned and washed in boiling water after use.
3. *As to Bedding.* — Every woman prisoner should be furnished with a mattress. The mattress should have a smooth surface and be covered with rubber or other waterproof material. This should be encased in a slip of washable material or covered with a sheet. These slips or sheets should be changed for each occupant and washed. Both mattresses and coverings should be removed from the cells during the day and thoroughly aired.
4. *As to Ventilation.* — All cells should be adequately ventilated. (Cells ventilated by means of openings into ventilating flues must have some means, mechanical or other, for creating a circulation of air.)

In a number of instances no material change in conditions observed at the time of first examination was noted on second examination. Many places were in good condition on first inspection, whereas others were not. In some cases very marked changes were made; for instance, in one town a lock-up was established in a new town hall; in several places plans were submitted for approval by the State Board of Health for a new station house, and in others the State Inspectors of Health reported the completion of new lock-ups and station houses following the approval of plans by the State Board of Health. In those instances where no material change in conditions was noted, steps were taken by the State Board of Health to have the State Inspectors of Health follow up recommendations and suggestions made. In some towns the motto seemed to be that "anything was good enough for tramps and drunks," while others endeavored to have places of detention come up to as high a standard as possible.

It was evident in many instances that more attention should be given to the care of drinking cups. There appeared to be a great tendency not to keep them in as cleanly a condition as they should be. It was observed that many times the cups were merely rinsed with faucet water, no attempt being made to sterilize them.

The following example of an excellent station house is worth detailing: —

A brick structure divided into two portions which may be described as (1) administrative and officers' quarters and (2) prisoners' quarters.

1. The administrative and officers' quarters are ample, clean, well lighted, well ventilated and in all respects satisfactory. The officers' dormitory has bathrooms connected and is a sanitary sleeping place.

2. The prisoners' quarters are divided into two sections: (*a*) for women and (*b*) for men.

(*a*) The women's section is presided over by the police matron who lives in the station house and is always on duty. There are 4 steel cells for women under arrest, in which the light is fairly good, the ventilation and cleanliness excellent. Each cell is provided with a steel bunk, a mattress, sheets and blankets, which are kept clean at all times by the matron. In each cell is a water-closet of good pattern which is frequently flushed.

There is also a special, clean, well-lighted and cheery room, provided with an excellent bed, for women under detention but not really under arrest, — those "held on suspicion" or for a few hours only.

A special bathroom with bathtub, which is kept scrupulously clean, is provided for women prisoners.

A special accident or emergency room is provided for women prisoners who may be ill or injured. In this are provisions for hot and cold running water, bandages, surgical dressings and instruments and a sterilizer for such minor operations as may be necessary, all thoroughly clean.

The police matron is provided with excellent quarters directly connected with the women's quarters. She provides meals for women under arrest and personally attends to washing the dishes. Every woman prisoner has her own drinking cup which is cleaned by the matron.

(*b*) The men's section has 15 steel cells on the street floor and 3 for dirty and noisy prisoners on the basement floor. These cells are of steel, with bars at their tops, and although somewhat small are well ventilated. The light in those distant from the windows is moderately poor, in the others fairly good. Cleanliness is excellent. The floors of the cell rooms are of concrete and slightly sloping, so that a hose may be turned into the cells and they may be thoroughly washed out. Clean mattresses and blankets are used in steel bunks. Every cell is provided with a good water-closet which is frequently flushed to the sewer by the janitor who is in constant attendance.

An emergency room for males under arrest, similar to that for women as above described, is provided.

Individual drinking cups are provided and well cared for. Coffee is the only food or drink provided for males; meals when desired are brought in from various restaurants.

The cleanliness observed in this station house was worthy of commendation, particularly in the quarters for women under arrest.

This first examination of jails, houses of correction and reformatories revealed the fact that as a rule they were in a condition worthy of commendation. In a few instances, while a jail or house of correction might be termed as a well kept and well managed institution, it might not be up to the standard of modern day architecture. The bucket system for the disposal of excrement, for example, was an objectionable feature.

INSPECTION OF SLAUGHTERHOUSES.

Slaughterhouse conditions were found to be improving, although there were a number of complaints received of violations of the laws regarding the inspection of slaughtering and the slaughtering of diseased animals.

It was suspected that in many instances cattle were taken to some place, either within or without the State, where inspection was lax, slaughtered and brought back to be sold.

Many towns had either no inspector or one who was incompetent, and the opinion was that all slaughtering should be done in district or municipal slaughterhouses under the supervision of the State.

In two instances slaughtered animals were seized and condemned as being tubercular.

There was a prosecution in the town of Wilbraham for slaughtering in the absence of the inspector. The man was fined $50 on one count, and on the other count — that of having in his possession, with intent to sell, unstamped meat — the case was continued from day to day.

Conditions noted specifically in certain towns are as follows: —

Abington. — The slaughterhouse has been made over, as requested by the local board.

Brockton. — The inspection work is carefully carried out.

Fairhaven. — Complaints of slaughtering diseased animals led to an investigation. Five animals found to be tubercular were seized and destroyed and the inspectors were examined and approved.

Lawrence. — The board of health, recognizing the practice of driving cattle, etc., across the New Hampshire border to be slaughtered and bringing the carcasses back into Massachusetts, bearing the New Hampshire inspection stamp, after a conference with the State Inspector of Health, adopted the following regulation: —

No carcasses or parts of carcasses of cattle, calves, sheep, swine or goats shall be sold or offered for sale in the city of Lawrence, unless, at the time at which such carcasses are inspected by the inspector of meats and provisions of the city of Lawrence, there be attached to such carcasses the thoracic organs, or unless such carcasses have been duly inspected and passed by a meat inspector of the United States Department of Agriculture, or by an inspector of a board of health, as provided in section 102 of chapter 56 of the Revised Laws and section 103 of said chapter as amended by section 471 of the Acts of 1909, or by an inspector of the State Board of Health, or by a State Inspector of Health, as provided in chapter 329 of the Acts of 1908, as amended by chapter 474 of the Acts of 1909.

Middleborough. — Inspection work in this town has been revolutionized since the appointment of the new inspector.

Palmer. — Changes suggested by the State Inspector of Health have been carried out.

Reading. — Illegal slaughtering has been discontinued.

Southampton. — One slaughterhouse was inspected and conditions were found to be good.

Swansea. — Violations of the law regarding slaughtering without a license and inspecting unlawfully slaughtered products led to an investigation. In consequence, both licensees and inspectors suffered suspension of licenses and official duties for periods of ten days each, and slaughterhouses were closed, cleaned up and made more satisfactory for carrying on business.

Westport. — Violations similar to those in Swansea resulted in the same methods of suspension, closure and cleaning up.

Wilbraham. — There was one prosecution for slaughtering in the absence of the inspector.

Worcester. — The records of the local inspectors showed a gradual decrease in the number of tubercular cattle slaughtered.

THE STATE INSPECTORS OF HEALTH.

HEALTH DISTRICT No. 1.

ADAM S. MACKNIGHT, M.D. (Jefferson Medical College, Philadelphia, 1888).

Hospital work,	1888–1890
Colliery surgeon, mining hospital, Luzerne County, Pennsylvania,	1890–1895
Deputy Medical Inspector to the Pennsylvania Board of Health,	1891–1895
Secretary, board of health, Freeland, Pa.,	1892–1895
Health Officer, Little Compton, R. I.,	1896–1899
Medical examiner, 1st district, Rhode Island,	1897–1900
Health officer, Tiverton, R. I.,	1899–1900
Physician in charge of the tuberculosis department of the City Hospital, Fall River,	1903–1907

Examining physician for the Massachusetts State Sanatorium at Rutland, 1903–1910
Appointed State Inspector of Health, 1907
President of the Association of the State Inspectors of Health of Massachusetts.
355 North Main Street, Fall River, Mass.

Health District No. 2.

Elliott Washburn, M.D. (Harvard Medical School, 1892).
House surgeon of Boston City Hospital, 1892–1893
Chairman of the Taunton board of health, 1896–1908
Appointed State Inspector of Health, 1907
50 Broadway, Taunton, Mass.

Health District No. 3.

Wallace C. Keith, A.B. (Amherst College, 1880), M.D. (Harvard Medical School, 1884).
Interne in Boston City Hospital, 1883–1885
Appointed State Inspector of Health, 1907
237 North Main Street, Brockton, Mass.

Health District No. 4.

Harry Linenthal, A.B. (Harvard College, 1900), M.D. (Harvard Medical School, 1904).
Volunteer assistant in neurological clinic, Massachusetts General Hospital, 1904–1907
Inspector of schools for the city of Boston, 1906–1908
Member of medical staff of Mt. Sinai Hospital Society since 1905
Assistant in Pulmonary diseases, Tufts College Medical School, since 1910
Appointed State Inspector of Health, 1907
442 Warren Street, Roxbury, Mass.

Health District No. 5.

Frank L. Morse, M.D. (Harvard Medical School, 1894).
Surgical house officer, Boston City Hospital, 1894–1896
Assistant resident physician, South Department, Boston City Hospital, 1896–1897
Medical and sanitary inspector to the Massachusetts State Board of Health, 1898–1905
Medical inspector to the Somerville board of health since 1903
Superintendent of the Somerville Hospital for Contagious Diseases since 1906
Appointed State Inspector of Health, 1909
78 Highland Avenue, Somerville, Mass.

HEALTH DISTRICT No. 6.

WILLIAM W. WALCOTT, S.B. (Massachusetts Institute of Technology, 1901), M.D. (Harvard Medical School, 1905).

House officer, Massachusetts General Hospital, ... 1905–1906

Appointed State Inspector of Health, ... 1907

32 West Central Street, Natick, Mass.

HEALTH DISTRICT No. 7.

J. WM. VOSS (St. Dunstan's College, 1891), M.D. (Medical Department of the University of Pennsylvania, 1894).

Appointed State Inspector of Health, ... 1907

366 Cabot Street, Beverly, Mass.

HEALTH DISTRICT No. 8.

WM. HALL COON, M.D. (Bellevue Hospital Medical College, New York, 1897).

Assistant physician, Northampton Insane Hospital, ... 1897–1898

Appointed State Inspector of Health, ... 1907

92 Main Street, Haverhill, Mass.

HEALTH DISTRICT No. 9.

CHARLES E. SIMPSON, M.D. (Harvard Medical School, 1883).

Superintendent of the hospital of the Lowell Hospital Association, Lowell, ... 1886–1911

Appointed State Inspector of Health, ... 1907

100 Holyrood Avenue, Lowell, Mass.

HEALTH DISTRICT No. 10.

LEWIS FISH, M.D. (Baltimore Medical College, 1898).

Appointed State Inspector of Health, ... 1907

86 Day Street, Fitchburg, Mass.

HEALTH DISTRICT No. 11.

MELVIN G. OVERLOCK, M.D. (Baltimore Medical College, 1896).

Appointed State Inspector of Health, ... 1907

91 Chandler Street, Worcester, Mass.

HEALTH DISTRICT No. 12.

JAMES V. W. BOYD, M.D. (College of Physicians and Surgeons, New York, 1894).

Interne, Randall's Island Hospital, ... 1895

Appointed State Inspector of Health, ... 1909

24 Oxford Street, Springfield, Mass.

Health District No. 13.

John S. Hitchcock, A.B., M.A. (Amherst College, 1889, 1905), M.D. (University of Maryland, School of Medicine, 1893).

Appointed State Inspector of Health,	1910

160 Main Street, Northampton, Mass.

Health District No. 14.

Lyman A. Jones, A.B., A.M. (Lawrence University, 1886, 1889), M.D. (Harvard Medical School, 1891).

House officer, Worcester City Hospital,	1890–1891
Assistant in Worcester Insane Hospital,	1892–1895
Studied in Germany,	1895–1896
Physician to North Adams board of health,	1903–1904
Appointed State Inspector of Health,	1907

Secretary of the Association of the State Inspectors of Health of Massachusetts.

141 Church Street, North Adams, Mass.

LIST OF CITIES AND TOWNS INCLUDED IN EACH HEALTH DISTRICT.

Health District No. 1.

Acushnet.
Barnstable.
Bourne.
Brewster.
Chatham.
Chilmark.
Dartmouth.
Dennis.
Eastham.
Edgartown.
Fairhaven.
Fall River.
Falmouth.
Freetown.
Gay Head.
Gosnold.
Harwich.
Marion.
Mashpee.
Mattapoisett.
Nantucket.
New Bedford.
Oak Bluffs.
Orleans.
Provincetown.
Rochester.
Sandwich.
Somerset.
Swansea.
Tisbury.
Truro.
Wareham.
Wellfleet.
West Tisbury.
Westport.
Yarmouth. — (36)

Health District No. 2.

Attleborough.
Avon.
Bellingham.
Berkley.
Blackstone.
Braintree.
Canton.
Dedham.
Dighton.
Easton.
Foxborough.
Franklin.
Holbrook.
Mansfield.
Milton.
Norfolk.
Norton.
North Attleborough.
Norwood.
Plainville.
Quincy.
Randolph.
Raynham.
Rehoboth.

Seekonk.
Sharon.
Stoughton.
TAUNTON.
Walpole.
Westwood.
Wrentham. — (31)

HEALTH DISTRICT No. 3.

Abington.
Bridgewater.
BROCKTON.
Carver.
Cohasset.
Duxbury.
East Bridgewater.
Halifax.
Hanover.
Hanson.
Hingham.
Hull.
Kingston.
Lakeville.
Marshfield.
Middleborough.
Norwell.
Pembroke.
Plymouth.
Plympton.
Rockland.
Scituate.
West Bridgewater.
Weymouth.
Whitman. — (25)

HEALTH DISTRICT No. 4.

BOSTON.
CHELSEA.
Revere.
Winthrop. — (4)

HEALTH DISTRICT No. 5.

Arlington.
Belmont.
CAMBRIDGE.
EVERETT.
MALDEN.
MEDFORD.
MELROSE.
North Reading.
Reading.
SOMERVILLE.
Stoneham.
Wakefield.
WALTHAM.
Watertown. — (14)

HEALTH DISTRICT No. 6.

Ashland.
Brookline.
Dover.
Framingham.
Grafton.
Holliston.
Hopedale.
Hopkinton.
MARLBOROUGH.
Medfield.
Medway.
Mendon.
Milford.
Millis.
Natick.
Needham.
NEWTON.
Northborough.
Sherborn.
Shrewsbury.
Southborough.
Sudbury.
Upton.
Wayland.
Wellesley.
Westborough.
Weston. — (27)

HEALTH DISTRICT No. 7.

BEVERLY.
Danvers.
Essex.
GLOUCESTER.
Hamilton.
Ipswich.
LYNN.
Lynnfield.
Manchester.
Marblehead.
Middleton.
Nahant.
Peabody.
Rockport.
SALEM.
Saugus.
Swampscott.
Topsfield.
Wenham. — (19)

Health District No. 8.

Amesbury.
Andover.
Boxford.
Georgetown.
Groveland.
HAVERHILL.
LAWRENCE.
Merrimac.
Methuen.
Newbury.
NEWBURYPORT.
North Andover.
Rowley.
Salisbury.
West Newbury.—(15)

Health District No. 9.

Acton.
Ayer.
Bedford.
Billerica.
Boxborough.
Burlington.
Carlisle.
Chelmsford.
Concord.
Dracut.
Dunstable.
Groton.
Harvard.
Lexington.
Lincoln.
Littleton.
LOWELL.
Maynard.
Pepperell.
Shirley.
Stow.
Tewksbury.
Townsend.
Tyngsborough.
Westford.
Wilmington.
Winchester.
WOBURN. — (28)

Health District No. 10.

Ashburnham.
Ashby.
Athol.
Barre.
Berlin.
Bolton.
Boylston.
Clinton.
Dana.
FITCHBURG.
Gardner.
Hardwick.
Holden.
Hubbardston.
Hudson.
Lancaster.
Leominster.
Lunenburg.
New Braintree.
Oakham.
Paxton.
Petersham.
Phillipston.
Princeton.
Royalston.
Rutland.
Sterling.
Templeton.
West Boylston.
Westminster.
Winchendon. — (31)

Health District No. 11.

Auburn.
Brimfield.
Brookfield.
Charlton.
Douglas.
Dudley.
Holland.
Leicester.
Millbury.
Northbridge.
North Brookfield.
Oxford.
Southbridge.
Spencer.
Sturbridge.
Sutton.
Uxbridge.
Wales.
Warren.
Webster.
West Brookfield.
WORCESTER. — (22)

Health District No. 12.

Agawam.
Blandford.
CHICOPEE.
East Longmeadow.
Enfield.
Granby.
Granville.
Greenwich.
Hampden.
HOLYOKE.
Huntington.
Longmeadow.
Ludlow.
Monson.
Montgomery.
Palmer.
Russell.
South Hadley.
Southwick.
SPRINGFIELD.
Tolland.
Ware.
West Springfield.
Westfield.
Wilbraham. — (25)

Health District No. 13.

Amherst.
Ashfield.
Belchertown.
Bernardston.
Buckland.
Chesterfield.
Colrain.
Conway.
Cummington.
Deerfield.
Easthampton.
Erving.
Gill.
Goshen.
Greenfield.
Hadley.
Hatfield.
Leverett.
Leyden.
Montague.
New Salem.
NORTHAMPTON.
Northfield.
Orange.
Pelham.
Plainfield.
Prescott.
Shelburne.
Shutesbury.
Southampton.
Sunderland.
Warwick.
Wendell.
Westhampton.
Whately.
Williamsburg. — (36)

Health District No. 14.

Adams.
Alford.
Becket.
Charlemont.
Cheshire.
Chester.
Clarksburg.
Dalton.
Egremont.
Florida.
Great Barrington.
Hancock.
Hawley.
Heath.
Hinsdale.
Lanesborough.
Lee.
Lenox.
Middlefield.
Monroe.
Monterey.
Mount Washington.
New Ashford.
New Marlborough.
NORTH ADAMS.
Otis.
Peru.
PITTSFIELD.
Richmond.
Rowe.
Sandisfield.
Savoy.
Sheffield.
Stockbridge.
Tyringham.
Washington.
West Stockbridge.
Williamstown.
Windsor.
Worthington. — (40)

Cities and Towns alphabetically arranged.

Health District Number.	City or Town.	County.
3	Abington,	Plymouth.
9	Acton,	Middlesex.
1	Acushnet,	Bristol.
14	Adams,	Berkshire.
12	Agawam,	Hampden.
14	Alford,	Berkshire.
8	Amesbury,	Essex.
13	Amherst,	Hampshire.
8	Andover,	Essex.
5	Arlington,	Middlesex.
10	Ashburnham,	Worcester.
10	Ashby,	Middlesex.
13	Ashfield,	Franklin.
6	Ashland,	Middlesex.
10	Athol,	Worcester.
2	Attleborough,	Bristol.
11	Auburn,	Worcester.
2	Avon,	Norfolk.
9	Ayer,	Middlesex.
1	Barnstable,	Barnstable.
10	Barre,	Worcester.
14	Becket,	Berkshire.
9	Bedford,	Middlesex.
13	Belchertown,	Hampshire.
2	Bellingham,	Norfolk.
5	Belmont,	Middlesex.
2	Berkley,	Bristol.
10	Berlin,	Worcester.
13	Bernardston,	Franklin.
7	BEVERLY,	Essex.
9	Billerica,	Middlesex.
2	Blackstone,	Worcester.
12	Blandford,	Hampden.
10	Bolton,	Worcester.
4	BOSTON,	Suffolk.
1	Bourne,	Barnstable.
9	Boxborough,	Middlesex.
8	Boxford,	Essex.
10	Boylston,	Worcester.
2	Braintree,	Norfolk.
1	Brewster,	Barnstable.
3	Bridgewater,	Plymouth.
11	Brimfield,	Hampden.
3	BROCKTON,	Plymouth.
11	Brookfield,	Worcester.
6	Brookline,	Norfolk.
13	Buckland,	Franklin.
9	Burlington,	Middlesex.
5	CAMBRIDGE,	Middlesex.
2	Canton,	Norfolk.
9	Carlisle,	Middlesex.
3	Carver,	Plymouth.
14	Charlemont,	Franklin.
11	Charlton,	Worcester.
1	Chatham,	Barnstable.
9	Chelmsford,	Middlesex.
4	CHELSEA,	Suffolk.
14	Cheshire,	Berkshire.
14	Chester,	Hampden.
13	Chesterfield,	Hampshire.
12	CHICOPEE,	Hampden.
1	Chilmark,	Dukes.
14	Clarksburg,	Berkshire.
10	Clinton,	Worcester.
3	Cohasset,	Norfolk.
13	Colrain,	Franklin.
9	Concord,	Middlesex.
13	Conway,	Franklin.
13	Cummington,	Hampshire.
14	Dalton,	Berkshire.
10	Dana,	Worcester.
7	Danvers,	Essex.
1	Dartmouth,	Bristol.
2	Dedham,	Norfolk.
13	Deerfield,	Franklin.
1	Dennis,	Barnstable.
2	Dighton,	Bristol.
11	Douglas,	Worcester.
6	Dover,	Norfolk.
9	Dracut,	Middlesex.
11	Dudley,	Worcester.
9	Dunstable,	Middlesex.
3	Duxbury,	Plymouth.
3	East Bridgewater,	Plymouth.
12	East Longmeadow,	Hampden.
1	Eastham,	Barnstable.
13	Easthampton,	Hampshire.
2	Easton,	Bristol.
1	Edgartown,	Dukes.
14	Egremont,	Berkshire.
12	Enfield,	Hampshire.
13	Erving,	Franklin.
7	Essex,	Essex.
5	EVERETT,	Middlesex.
1	Fairhaven,	Bristol.
1	FALL RIVER,	Bristol.
1	Falmouth,	Barnstable.
10	FITCHBURG,	Worcester.
14	Florida,	Berkshire.
2	Foxborough,	Norfolk.
6	Framingham,	Middlesex.
2	Franklin,	Norfolk.
1	Freetown,	Bristol.
10	Gardner,	Worcester.
1	Gay Head,	Dukes.
8	Georgetown,	Essex.
13	Gill,	Franklin.
7	GLOUCESTER,	Essex.
13	Goshen,	Hampshire.
1	Gosnold,	Dukes.
6	Grafton,	Worcester.
12	Granby,	Hampshire.
12	Granville,	Hampden.
14	Great Barrington,	Berkshire.
13	Greenfield,	Franklin.
12	Greenwich,	Hampshire.
9	Groton,	Middlesex.
8	Groveland,	Essex.
13	Hadley,	Hampshire.
3	Halifax,	Plymouth.
7	Hamilton,	Essex.
12	Hampden,	Hampden.
14	Hancock,	Berkshire.
3	Hanover,	Plymouth.
3	Hanson,	Plymouth.
10	Hardwick,	Worcester.
9	Harvard,	Worcester.
1	Harwich,	Barnstable.
13	Hatfield,	Hampshire.
8	HAVERHILL,	Essex.
14	Hawley,	Franklin.
14	Heath,	Franklin.
3	Hingham,	Plymouth.
14	Hinsdale,	Berkshire.
2	Holbrook,	Norfolk.
10	Holden,	Worcester.
11	Holland,	Hampden.

Cities and Towns alphabetically arranged — Continued.

Health District Number.	City or Town.	County.
6	Holliston,	Middlesex.
12	HOLYOKE,	Hampden.
6	Hopedale,	Worcester.
6	Hopkinton,	Middlesex.
10	Hubbardston,	Worcester.
10	Hudson,	Middlesex.
3	Hull,	Plymouth.
12	Huntington,	Hampshire.
2	Hyde Park,	Norfolk.
7	Ipswich,	Essex.
3	Kingston,	Plymouth.
3	Lakeville,	Plymouth.
10	Lancaster,	Worcester.
14	Lanesborough,	Berkshire.
8	LAWRENCE,	Essex.
14	Lee,	Berkshire.
11	Leicester,	Worcester.
14	Lenox,	Berkshire.
10	Leominster,	Worcester.
13	Leverett,	Franklin.
9	Lexington,	Middlesex.
13	Leyden,	Franklin.
9	Lincoln,	Middlesex.
9	Littleton,	Middlesex.
12	Longmeadow,	Hampden.
9	LOWELL,	Middlesex.
12	Ludlow,	Hampden.
10	Lunenburg,	Worcester.
7	LYNN,	Essex.
7	Lynnfield,	Essex.
5	MALDEN,	Middlesex.
7	Manchester,	Essex.
2	Mansfield,	Bristol.
7	Marblehead,	Essex.
1	Marion,	Plymouth.
6	MARLBOROUGH,	Middlesex.
3	Marshfield,	Plymouth.
1	Mashpee,	Barnstable.
1	Mattapoisett,	Plymouth.
9	Maynard,	Middlesex.
6	Medfield,	Norfolk.
5	MEDFORD,	Middlesex.
6	Medway,	Norfolk.
5	MELROSE,	Middlesex.
6	Mendon,	Worcester.
8	Merrimac,	Essex.
8	Methuen,	Essex.
3	Middleborough,	Plymouth.
14	Middlefield,	Hampshire.
7	Middleton,	Essex.
6	Milford,	Worcester.
11	Millbury,	Worcester.
6	Millis,	Norfolk.
2	Milton,	Norfolk.
14	Monroe,	Franklin.
12	Monson,	Hampden.
13	Montague,	Franklin.
14	Monterey,	Berkshire.
12	Montgomery,	Hampden.
14	Mount Washington,	Berkshire.
7	Nahant,	Essex.
1	Nantucket,	Nantucket.
6	Natick,	Middlesex.
6	Needham,	Norfolk.
14	New Ashford,	Berkshire.
1	NEW BEDFORD,	Bristol.
10	New Braintree,	Worcester.
14	New Marlborough,	Berkshire.
13	New Salem,	Franklin.
8	Newbury,	Essex.
8	NEWBURYPORT,	Essex.
6	NEWTON,	Middlesex.
2	Norfolk,	Norfolk.
14	NORTH ADAMS,	Berkshire.
8	North Andover,	Essex.
2	North Attleborough,	Bristol.
11	North Brookfield,	Worcester.
5	North Reading,	Middlesex.
13	NORTHAMPTON,	Hampshire.
6	Northborough,	Worcester.
11	Northbridge,	Worcester.
13	Northfield,	Franklin.
2	Norton,	Bristol.
3	Norwell,	Plymouth.
2	Norwood,	Norfolk.
1	Oak Bluffs,	Dukes.
10	Oakham,	Worcester.
13	Orange,	Franklin.
1	Orleans,	Barnstable.
14	Otis,	Berkshire.
11	Oxford,	Worcester.
12	Palmer,	Hampden.
10	Paxton,	Worcester.
7	Peabody,	Essex.
13	Pelham,	Hampshire.
3	Pembroke,	Plymouth.
9	Pepperell,	Middlesex.
14	Peru,	Berkshire.
10	Petersham,	Worcester.
10	Phillipston,	Worcester.
14	PITTSFIELD,	Berkshire.
13	Plainfield,	Hampshire.
2	Plainville,	Norfolk.
3	Plymouth,	Plymouth.
3	Plympton,	Plymouth.
13	Prescott,	Hampshire.
10	Princeton,	Worcester.
1	Provincetown,	Barnstable.
2	QUINCY,	Norfolk.
2	Randolph,	Norfolk.
2	Raynham,	Bristol.
5	Reading,	Middlesex.
2	Rehoboth,	Bristol.
4	Revere,	Suffolk.
14	Richmond,	Berkshire.
1	Rochester,	Plymouth.
3	Rockland,	Plymouth.
7	Rockport,	Essex.
14	Rowe,	Franklin.
8	Rowley,	Essex.
10	Royalston,	Worcester.
12	Russell,	Hampden.
10	Rutland,	Worcester.
7	SALEM,	Essex.
8	Salisbury,	Essex.
14	Sandisfield,	Berkshire.
1	Sandwich,	Barnstable.
7	Saugus,	Essex.
14	Savoy,	Berkshire.
3	Scituate,	Plymouth.
2	Seekonk,	Bristol.
2	Sharon,	Norfolk.

Cities and Towns alphabetically arranged — Concluded.

Health District Number.	City or Town.	County.	Health District Number.	City or Town.	County.
14	Sheffield,	Berkshire.	12	Ware,	Hampshire.
13	Shelburne,	Franklin.	1	Wareham,	Plymouth.
6	Sherborn,	Middlesex.	11	Warren,	Worcester.
9	Shirley,	Middlesex.	13	Warwick,	Franklin.
6	Shrewsbury,	Worcester.	14	Washington,	Berkshire.
13	Shutesbury,	Franklin.	5.	Watertown,	Middlesex.
1	Somerset,	Bristol.	6	Wayland,	Middlesex.
5	SOMERVILLE,	Middlesex.	11	Webster,	Worcester.
12	South Hadley,	Hampshire.	6	Wellesley,	Norfolk.
13	Southampton,	Hampshire.	1	Wellfleet,	Barnstable.
6	Southborough,	Worcester.	13	Wendell,	Franklin.
11	Southbridge,	Worcester.	7	Wenham,	Essex.
12	Southwick,	Hampden.	10	West Boylston,	Worcester.
11	Spencer,	Worcester.	3	West Bridgewater,	Plymouth.
12	SPRINGFIELD,	Hampden.	11	West Brookfield,	Worcester.
10	Sterling,	Worcester.	8	West Newbury,	Essex.
14	Stockbridge,	Berkshire.	12	West Springfield,	Hampden.
5	Stoneham,	Middlesex.	14	West Stockbridge,	Berkshire.
2	Stoughton,	Norfolk.	1	West Tisbury,	Dukes.
9	Stow,	Middlesex.	6	Westborough,	Worcester.
11	Sturbridge,	Worcester.	12	Westfield,	Hampden.
6	Sudbury,	Middlesex.	9	Westford,	Middlesex.
13	Sunderland,	Franklin.	13	Westhampton,	Hampshire.
11	Sutton,	Worcester.	10	Westminster,	Worcester.
7	Swampscott,	Essex.	6	Weston,	Middlesex.
1	Swansea,	Bristol.	1	Westport,	Bristol.
			2	Westwood,	Norfolk.
2	TAUNTON,	Bristol.	3	Weymouth,	Norfolk.
10	Templeton,	Worcester.	13	Whately,	Franklin.
9	Tewksbury,	Middlesex.	3	Whitman,	Plymouth.
1	Tisbury,	Dukes.	12	Wilbraham,	Hampden.
12	Tolland,	Hampden.	13	Williamsburg,	Hampshire.
7	Topsfield,	Essex.	14	Williamstown,	Berkshire.
9	Townsend,	Middlesex.	9	Wilmington,	Middlesex.
1	Truro,	Barnstable.	10	Winchendon,	Worcester.
9	Tyngsborough,	Middlesex.	9	Winchester,	Middlesex.
14	Tyringham,	Berkshire.	14	Windsor,	Berkshire.
			4	Winthrop,	Suffolk.
6	Upton,	Worcester.	9	WOBURN,	Middlesex.
11	Uxbridge,	Worcester.	11	WORCESTER,	Worcester.
			14	Worthington,	Hampshire.
5	Wakefield,	Middlesex.	2	Wrentham,	Norfolk.
11	Wales,	Hampden.			
2	Walpole,	Norfolk.	1	Yarmouth,	Barnstable.
5	WALTHAM,	Middlesex.			

STATISTICAL SUMMARIES

OF

DISEASE AND MORTALITY.

A GENERAL REVIEW OF THE VITAL STATISTICS OF THE STATE.

1911.

The number of deaths in the State in 1911 was 53,062, which was equivalent to a death-rate of 15.42 per 1,000 upon an estimated population of 3,444,059.

The mean death-rate of the five years, 1907, 1908, 1909, 1910 and 1911, was 16.34, as compared with 16.33 for the previous five years.

The following figures are presented for the ten years ended with 1911: —

Massachusetts.

YEARS.	Population.[1]	Deaths.	Death-rates.	YEARS.	Population.[1]	Deaths.	Death-rates.
1902, . .	2,937,600	47,491	16.17	1907, . .	3,086,885	54,234	17.57
1903, . .	3,006,040	49,054	16.32	1908, . .	3,129,348	51,788	16.55
1904, . .	3,076,083	48,482	15.76	1909, . .	3,172,395	51,236	16.16
1905, . .	3,003,680	50,486	16.81	1910, . .	3,366,416	54,407	16.16
1906, . .	3,044,998	50,624	16.63	1911, . .	3,444,059	53,062	15.42

[1] Population estimated for intercensal years.

INFECTIVE DISEASES.

The death-rate from the principal infective diseases in 1911 was considerably less than that of 1910. There was a decrease in the number of deaths from diphtheria, scarlet fever, typhoid fever, measles, cholera infantum, consumption, dysentery, pneumonia and cerebro-spinal meningitis, and an increase in the deaths from whooping cough and cancer. There were two deaths from smallpox.

The deaths and death-rates from each of the foregoing diseases in the past five years are shown in the following table: —

Deaths and Death-rates from Certain Diseases in Massachusetts, 1907–1911.

	1907.		1908.		1909.		1910.		1911.	
	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.
Smallpox,	6	.019	3	.01	1	.003	-	-	2	.006
Diphtheria,	752	2.44	747	2.38	694	2.19	679	2.02	563	1.63
Scarlet fever,	285	.92	369	1.15	259	.82	254	.75	184	.53
Typhoid fever,	389	1.26	517	1.65	390	1.23	411	1.22	302	.88
Measles,	163	.53	331	1.06	157	.49	240	.71	158	.46
Cholera infantum,	2,696	8.73	2,691	8.60	2,855	9.00	3,744	11.12	3,275	9.51
Consumption,	4,771	15.46	4,445	14.20	4,393	13.85	4,503	13.38	4,418	12.83
Dysentery,	169	.55	225	.72	215	.68	210	.62	148	.43
Whooping cough,	243	.79	288	.92	250	.79	183	.54	292	.85
Pneumonia,	5,709	18.50	5,363	17.14	5,635	17.76	6,678	19.84	5,991	17.39
Cancer,	2,744	8.89	2,814	8.99	2,871	9.05	3,028	8.99	3,199	9.29
Cerebro-spinal meningitis,	434	1.41	181	.58	124	.39	153	.45	143	.42

In the following table a balance is presented between the deaths from the principal infective diseases in the two years 1910 and 1911, by which it appears that the sum of the deaths from these twelve causes in 1911 was lower by 1,408 than those of 1910 from the same causes: —

Deaths from Certain Infective Diseases in 1910 and 1911.

	1910.	1911.	Increase.	Decrease.
Smallpox,	-	2	2	-
Diphtheria and croup,	679	563	-	116
Scarlet fever,	254	184	-	70
Typhoid fever,	411	302	-	109
Measles,	240	158	-	82
Cholera infantum,	3,744	3,275	-	469
Consumption,	4,503	4,418	-	85
Dysentery,	210	148	-	62
Whooping cough,	183	292	109	-
Pneumonia,	6,678	5,991	-	687
Cancer,	3,028	3,199	171	-
Cerebro-spinal meningitis,	153	143	-	10
Totals,	20,083	18,675	282	1,690

INFANT MORTALITY.

The rate of infant mortality during the year 1911 was the lowest for the 10-year period 1902–1911, as shown by the following table.

The total number of births which occurred during the year ended June 30, 1911, was 87,221, and the total deaths under one during the year ended Dec. 31, 1911, were 10,543.

For the sake of accuracy the death-rate of infants under one year old is obtained by comparing the deaths of such infants occurring in a year with the mean number of infants under one living throughout a year, and this number must "lie between the annual number of births and that number diminished by the deaths under one. It would be nearer the latter than the former number on account of the excess of deaths in the first months of life" (Dr. Farr). In the following table the births in the first line are those which occurred between July 1, 1901, and June 30, 1902, inclusive, and so on through the table, the births in the last line being those for the year ended June 30, 1911.

The deaths under one in the same table are those of the calendar years ended Dec. 31, 1902, 1903, etc. The births during these ten years were 798,866, and the deaths under one year were 107,595, which is equivalent to an infant mortality-rate of 134.7 per 1,000 births for the decade. The last half of the period shows a gain over the first half, since the infantile death-rate in the last five years was 130.1 per 1,000 births, as compared with 139.9 in the first five years.

Infant Mortality, Massachusetts, 1902–1911, Ten Years.

YEARS.	Births in Year ending June 30.	Deaths under One Year.	Death-rate under One Year per 1,000 Births.	YEARS.	Births in Year ending June 30.	Deaths under One Year.	Death-rate under One Year per 1,000 Births.
1902, . .	71,770	10,075	140.4	1907, . .	83,230	11,293	135.7
1903, . .	73,618	10,269	139.5	1908, . .	87,112	11,606	133.2
1904, . .	74,791	9,992	133.6	1909, . .	84,352	10,693	126.8
1905, . .	74,387	10,519	141.4	1910, . .	85,655	11,499	134.2
1906, . .	76,730	11,106	144.7	1911, . .	87,221	10,543	120.9

Total births in ten years ended June 30, 1911, 798,866.
Total deaths under one in ten years ended Dec. 31, 1911, 107,595.
Mean infantile death-rate, 134.7 per 1,000 births.

CONSUMPTION.

The total number of deaths from this cause registered in 1911 was 4,418, a decrease of 85 in the number of deaths occurring from this disease in 1910. The death-rate from consumption was less in 1911 than that of any year of record.

The following figures present the deaths and death-rates, by ten-year periods, during the past sixty years 1851–1910, and for the year 1911: —

Deaths and Death-rates from Consumption in Massachusetts, 1851–1911.

PERIODS.	Deaths.	Death-rates per 10,000.	PERIODS.	Deaths.	Death-rates per 10,000.
1851–60, ...	45,252	39.9	1891–1900, . . .	54,374	21.4
1861–70, ...	45,913	34.9	1901–10, ...	46,545	15.2
1871–80, ...	54,039	32.7	1911, ...	4,418	12.8
1881–90, ...	58,303	29.2			

TYPHOID FEVER.

The following table presents the deaths and death-rates of these cities from this cause during the year 1911: —

Deaths and Death-rates from Typhoid Fever in the Cities of Massachusetts, 1911.

CITIES.	Deaths from Typhoid Fever.	Death-rates per 10,000.	CITIES.	Deaths from Typhoid Fever.	Death-rates per 10,000.
Newburyport, . . .	5	3.3	Somerville, . . .	6	.8
Beverly, ...	6	3.1	Marlborough, . . .	1	.7
New Bedford, . . .	23	2.3	Holyoke, ...	4	.7
Springfield, . . .	19	2.1	Haverhill, ...	3	.7
North Adams, . . .	4	1.8	Woburn, ...	1	.6
Northampton, . . .	3	1.5	Lowell, ...	7	.6
Pittsfield, ...	5	1.5	Worcester, ...	9	.6
Fall River, . . .	18	1.5	Quincy, ...	2	.6
Taunton, ...	5	1.4	Everett, ...	2	.6
Chelsea, ...	4	1.2	Salem, ...	2	.4
Lawrence, ...	10	1.1	Cambridge, . . .	3	.3
Malden, ...	5	1.1	Newton, ...	1	.3
Waltham, ...	3	1.1	Brockton, ...	1	.2
Lynn, ...	9	1.0	Chicopee, ...	-	-
Boston, ...	60	.9	Medford, ...	-	-
Gloucester, . . .	2	.8	Melrose, ...	-	-
Fitchburg, . . .	3	.8			

Death-rate for the above 33 cities, 1911, 1.0.

Following is a condensed summary from the report of 1900, from which it can be seen that a decided and continuous improvement in the death-rate from typhoid fever is taking place: —

Death-rates from Typhoid Fever per 10,000, 1871–1911, Massachusetts.

1871–75,	8.2	1896–1900,	2.6
1876–80,	4.2	1901–05,	1.9
1881–85,	4.1	1906–10,	1.4
1886–90,	4.6	1911,	.9
1891–95,	3.4		

For the entire State the death-rates from this cause in 1901, 1902, 1903, 1904, 1905, 1906, 1907, 1908, 1909, 1910 and 1911 were, respectively, 1.95, 1.83, 1.75, 1.75, 1.73, 1.57, 1.26, 1.65, 1.23, 1.22 and .88 per 10,000 inhabitants.

The highest death-rates from this cause among the cities appear to have occurred in Newburyport (3.3), Beverly (3.1), New Bedford (2.3) and Springfield (2.1); and the lowest occurred in Brockton (0.2), Newton (0.3) and Cambridge (0.3). Chicopee reported 44 cases of typhoid fever, Medford 9 cases and Melrose 6 cases, with no deaths.

DIPHTHERIA.

The following table shows the deaths and death-rates from diphtheria by five-year periods from 1876 to 1910, and for the year 1911: —

Deaths and Death-rates from Diphtheria per 10,000, 1876–1911, Massachusetts.

YEARS.	Deaths.	Death-rates.	YEARS.	Deaths.	Death-rates.
1876–80,	13,676	15.8	1896–1900,	6,331	4.7
1881–85,	8,944	9.5	1901–05,	4,259	2.9
1886–90,	8,857	8.4	1906–10,	3,615	2.3
1891–95,	7,652	6.4	1911,	563	1.6

Further and more definite information relative to diphtheria may be found in that portion of the report which relates to the production and distribution of antitoxin.

OTHER PREVENTABLE DISEASES.

The following table presents the deaths and death-rates from measles, scarlet fever, dysentery, cholera infantum, and whooping cough for the period of forty-six years, 1866–1911: —

Deaths and Death-rates in Massachusetts per 10,000 Living from Certain Infective Diseases by Five-year Periods, 1866–1910, and for the Year 1911.

	MEASLES.		SCARLET FEVER.		DYSENTERY.		CHOLERA INFANTUM.		WHOOPING COUGH.	
	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.
1866–70,	1,081	1.6	4,670	6.8	3,244	4.7	6,943	10.1	1,481	2.1
1871–75,	1,133	1.4	6,782	8.6	2,191	2.8	12,453	15.8	1,561	2.0
1876–80,	742	.9	3,517	4.1	2,366	2.7	9,054	10.5	1,493	1.7
1881–85,	1,007	1.1	2,504	2.7	1,601	1.7	9,894	10.5	1,213	1.3
1886–90,	1,089	1.0	1,810	1.7	1,276	1.2	10,904	10.3	1,421	1.3
1891–95,	815	.7	2,857	2.4	1,083	.9	13,426	11.2	1,445	1.2
1896–1900,	948	.7	1,358	1.0	1,434	1.1	11,865	8.9	1,465	1.1
1901–1905,	1,090	.7	1,463	1.0	970	.7	13,245	9.1	1,401	1.0
1906–1910,	1,099	.7	1,302	.8	995	.6	14,511	9.2	1,473	.9
1911,	158	.5	184	.5	148	.4	3,275	9.5	292	.9

The deaths from cerebro-spinal meningitis were 143, a decrease from the number of deaths recorded in 1910, and represented a death-rate of .42 per 10,000 living. In 1910 the death-rate was .45.

There were 27 deaths from tetanus during the year, 3 from actinomycosis, 1 from glanders, 2 from malignant pustule or charbon (anthrax). 1 from pellagra, 1 from rabies and 1 from Asiatic cholera.

RETURNS OF DISEASE AND MORTALITY.

The statistical information relating to disease and mortality which has been received by the Board during each year, either through the medium of voluntary returns or in consequence of legal requirements, has, in the recent reports of the Board, been presented under four different heads or groups. Since 1902, this series of statistics has been condensed as much as can be done consistently with a clear and intelligent method of presentation.

These summaries are defined as follows: —

I. *The Weekly Mortality Returns.* — These consist of the reports of deaths, which are made up weekly and are sent to the office of the State Board by the registration officials of cities and towns. They serve principally to show the seasonal prevalence of each of the chief infective diseases, and the mortality of children under five years old, in weekly periods. Beginning with the year 1875, this series of statistics has been annually reported (see page 475 of report for that year), and was first published as a summary in the report of 1883.

II. *The Reports of Certain Infective Diseases, — Diphtheria, Scarlet Fever, Typhoid Fever and Measles.* — These are obtained from the reports of local boards of health forwarded during 1911 to the State Board as cases arose. By comparing the numbers of reported cases with the reported deaths, the mean fatality of each disease in the places from which the reports are made is obtained with a reasonable degree of accuracy.

III. *Reports of Cities and Towns, made under the Provisions of Chapter 75, Section 52, of the Revised Laws.* — By this act each local board of health is required to report to the State Board every case of "disease dangerous to the public health" which is reported to the local board. A digest of these reports is presented in Summary No. III. This summary was first published in the report of 1893, page 639.

IV. *Annual Reports made under the Provisions of Chapter 75, Section 12, of the Revised Laws.* — The full reports of deaths occurring in each city and town having over 5,000 inhabitants comprise another series of returns, which are summarized in No. IV. The population of these cities and towns, as estimated in 1911, constituted about 89 per cent. of the total population of the State. These reports are made under the requirements of the following statute: —

> In each city and town having a population of more than five thousand inhabitants, as determined by the last census, at least one member of said board shall be a physician, and the board shall send an annual report of the deaths in such town to the state board of health. The form of such reports shall be prescribed and furnished by the state board of health. (Revised Laws, chapter 75, section 12.)

This summary was first presented in the report of 1894.

NOTE. — A supply of the postal cards, necessary for the reporting of voluntary mortality returns such as are required for the data presented in Section I. of the following summary, will be forwarded to the registration officers of any city or town who are willing to contribute the necessary information.

Postal cards are also sent to all boards of health in the State, for the purpose of aiding them to comply with the provisions of chapter 75, section 52, of the Revised Laws, relative to the reporting of diseases dangerous to the public health to the State Board immediately after reports of the same are received by the local board.

Annual blank forms are also sent to each local board of health in cities and towns having over 5,000 inhabitants, for the return of such information as is called for by the provisions of chapter 75, section 12, of the Revised Laws.

I.

THE WEEKLY MORTALITY RETURNS.

In the following summary, the voluntary reports of deaths received at the close of each week from the city registrars, town clerks and boards of health of the cities and towns are epitomized for the year ended Dec. 31, 1911. The chief value of this abstract consists in the fact that it presents a continuous history of the mortality from certain specified diseases from week to week throughout the year.

This weekly report has been published in the Boston Medical and Surgical Journal every week for a period of twenty-five years or more, and also in a publication of the Board, a weekly bulletin, since and including 1883.[1]

These returns are necessarily incomplete, since they are voluntary and consequently embrace the statistics of only a portion of the population, the reporting places being chiefly the cities and large towns.

The population of the cities and towns contributing to these returns during the year was 2,555,555, or 76 per cent. of the total population.

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[1] The bulletin was changed from a weekly to a monthly publication in January, 1906.

The following items are embraced in this summary: —

Total deaths reported for each week.
Deaths of children under five years.
Deaths from acute lung diseases.
Deaths from tuberculosis, pulmonary.
Deaths from tuberculosis other than pulmonary.
Deaths from diphtheria.
Deaths from typhoid fever.
Deaths from measles.
Deaths from cerebro-spinal meningitis.
Deaths from meningitis other than cerebro-spinal.
Deaths from whooping cough.
Deaths from scarlet fever.
Deaths from erysipelas.
Deaths from influenza.
Deaths from anterior poliomyelitis.
Deaths from tetanus.
Deaths from glanders.
Deaths from anthrax.
Deaths from pellagra.
Deaths from smallpox.

The following table contains a summary of the statistics compiled from these weekly returns of mortality: —

Summary, Jan. 1 to Dec. 31, 1911.

	Total Deaths.	Deaths under Five Years of Age.	Acute Lung Diseases.	Tuberculosis, Pulmonary.	Tuberculosis, other than Pulmonary.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Meningitis, other than Cerebro-spinal.	Whooping Cough.	Scarlet Fever.	Erysipelas.	Influenza.	Anterior Poliomyelitis.	Tetanus.	Glanders.	Anthrax.	Pellagra.	Smallpox.
1911.																				
January 7, ...	795	186	170	64	11	11	1	3	-	-	2	5	5	5	-	-	-	-	-	-
14, ...	793	172	145	61	12	15	6	3	3	-	2	5	1	3	-	-	-	-	-	-
21, ...	819	187	133	73	11	12	-	4	4	1	8	7	3	4	-	-	-	-	-	-
28, ...	815	219	132	68	14	12	3	3	1	-	8	4	1	2	-	-	-	-	-	-
February, 4, ...	831	202	154	55	19	8	-	5	3	-	9	10	8	3	1	-	-	-	-	-
11, ...	900	205	163	69	17	12	2	3	2	1	4	8	4	7	1	1	-	-	-	-
18, ...	902	211	228	82	17	12	2	3	2	1	9	1	8	2	-	-	1	-	-	-
25, ...	885	200	176	66	14	12	6	3	9	-	6	4	2	8	-	-	-	-	-	-
March 4, ...	820	204	163	69	8	15	5	2	3	1	10	6	2	8	-	-	-	-	-	-
11, ...	863	223	136	75	17	14	2	1	-	-	9	10	10	3	1	-	-	-	-	-
18, ...	887	226	143	74	15	9	2	6	3	1	7	9	7	13	-	-	-	-	-	-
25, ...	873	201	164	68	12	10	3	9	3	-	4	6	4	4	-	-	-	-	-	-
April 1, ...	816	200	136	79	10	11	4	4	2	1	12	3	4	6	-	-	-	-	-	-
8, ...	834	200	137	74	16	10	2	4	4	-	10	4	6	5	-	-	-	-	-	-
15, ...	811	206	121	69	14	7	2	9	2	2	8	2	4	1	-	-	-	-	-	-
22, ...	862	231	135	61	10	13	3	4	4	-	9	7	1	6	1	-	-	-	-	-
29, ...	769	193	133	64	11	10	2	8	4	2	8	2	2	3	-	-	-	-	-	-

May 6,	846	223	122	75	14	13	5	9	4	1	12	8	2	4	1	-	-	-	-	-
13,	815	227	127	56	12	12	-	8	3	-	14	4	9	2	1	-	-	-	-	-
20,	753	210	133	60	12	3	1	10	3	2	3	6	2	-	1	-	-	-	-	-
27,	726	191	96	52	10	3	5	2	2	1	3	1	1	3	-	-	-	-	-	-
June 3,	620	162	67	42	12	5	3	6	2	-	6	2	6	6	-	-	-	1	-	-
10,	600	143	52	45	15	6	3	5	2	-	4	1	2	1	1	-	-	-	-	-
17,	591	159	64	49	11	6	1	3	2	-	6	4	2	-	-	-	-	-	-	-
24,	623	181	60	55	12	6	4	7	-	1	2	2	-	-	-	-	-	-	-	-
July 1,	664	187	41	56	13	9	1	5	1	1	5	1	4	-	1	-	-	-	-	-
8,	1,327	361	70	62	18	7	5	3	5	-	3	2	1	-	-	-	-	-	-	-
15,	1,140	324	49	57	20	4	3	4	1	-	3	2	2	-	-	-	-	-	-	-
22,	737	290	44	60	10	5	4	3	2	1	5	-	1	-	1	-	-	-	-	-
29,	737	312	38	58	7	7	2	4	1	-	1	1	-	-	-	-	-	-	-	-
August 5,	750	318	39	49	10	6	4	2	6	-	5	3	1	-	-	-	-	-	1	-
12,	806	334	47	55	6	6	4	3	2	2	5	2	2	-	1	1	-	-	-	-
19,	760	340	42	55	19	3	6	2	2	-	8	1	1	-	1	1	-	-	-	-
26,	734	317	35	39	10	7	5	2	3	-	11	1	-	-	2	-	-	-	-	-
September 2,	695	262	36	49	11	4	5	-	2	1	6	-	-	-	1	-	-	-	-	-
9,	685	251	43	41	8	2	6	5	3	-	2	3	2	-	3	-	-	-	-	-
16,	751	256	46	54	11	4	12	3	2	-	4	2	-	-	1	-	-	-	-	-
23,	699	225	40	41	9	10	11	-	-	-	3	3	1	-	-	1	-	-	-	-
30,	722	228	51	53	11	14	11	2	2	-	3	2	2	-	-	-	-	-	-	-
October 7,	631	207	62	51	9	10	8	1	1	-	1	-	1	-	2	-	-	-	-	-
14,	647	171	66	44	12	7	7	1	1	1	2	1	-	-	2	-	-	-	-	-

Summary, Jan. 1 to Dec. 31, 1911 — Concluded.

1911.	Total Deaths.	Deaths under Five Years of Age.	Acute Lung Diseases.	Tuberculosis, Pulmonary.	Tuberculosis, other than Pulmonary.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Meningitis, other than Cerebro-spinal.	Whooping Cough.	Scarlet Fever.	Erysipelas.	Influenza.	Anterior Poliomyelitis.	Tetanus.	Glanders.	Anthrax.	Pellagra.	Smallpox.
October 21,	617	181	55	40	7	7	9	-	1	-	2	1	2	-	1	-	-	-	-	-
28,	623	161	57	51	9	5	7	3	4	-	6	-	-	-	-	-	-	-	-	-
November 4,	632	130	57	70	5	8	3	1	3	-	1	-	1	1	-	1	-	-	-	-
11,	685	158	80	45	4	8	9	5	3	1	3	3	-	-	1	-	-	-	-	-
18,	661	171	69	48	4	8	12	1	2	-	5	1	1	-	1	-	-	-	-	-
25,	645	156	82	51	7	9	5	2	1	-	4	1	1	-	1	-	-	-	-	-
December 2,	675	150	80	50	12	4	5	2	1	1	2	3	1	1	1	-	-	-	-	-
9,	713	150	117	57	7	13	6	-	2	-	5	2	-	2	-	-	-	-	-	2
16,	708	169	102	61	15	10	7	4	3	-	2	-	1	2	-	-	-	-	-	-
23,	670	160	107	60	6	10	6	3	2	-	4	3	2	3	1	-	-	-	-	-
30,	803	199	118	56	12	9	3	3	2	-	4	2	2	3	-	-	-	-	-	-
Totals,	39,766	11,130	4,963	3,018	598	443	233	188	125	23	280	156	125	111	29	5	1	1	1	2
Weekly average,	765	214	95	58	12	8.5	4.5	3.6	2.4	.44	5.4	3	2.4	2.1	.56	.10	.02	.02	.02	.04
Rate per 1,000 deaths,	-	279.9	124.8	75.9	15.0	11.1	5.9	4.7	3.1	.58	7.04	3.9	3.1	2.8	.73	.13	.03	.03	.03	.05
Rate per 1,000 population,	15.56	4.36	1.94	1.18	.23	.17	.09	.07	.05	.009	.11	.06	.05	.04	.01	.002	.0004	.0004	,0004	.0003

Average reporting population, ... 2,555,555

Condensed Statistics embracing the Total Deaths, Deaths under Five Years, and Deaths from Certain Causes in Reporting Cities and Towns of Massachusetts for the Year ending Dec. 31, 1911.

	Deaths.	Average Number of Deaths in Each Week.	Percentage of Total Mortality.	Death-rate per 1,000 of Reporting Population.
Total deaths,	39,766	765	100.00	15.56
Deaths under five years,	11,130	214	27.99	4.36
Deaths from acute lung diseases,	4,963	95	12.48	1.94
Deaths from tuberculosis, pulmonary,	3,018	58	7.59	1.18
Deaths from tuberculosis other than pulmonary,	598	12	1.50	.23
Deaths from diphtheria,	443	8.5	1.11	.17
Deaths from typhoid fever,	233	4.5	.59	.09
Deaths from measles,	188	3.6	.47	.07
Deaths from cerebro-spinal meningitis,	125	2.4	.31	.05
Deaths from meningitis other than cerebro-spinal,	23	.4	.06	.009
Deaths from whooping cough,	280	5.4	.70	.11
Deaths from scarlet fever,	156	3.0	.39	.06
Deaths from erysipelas,	125	2.4	.31	.05
Deaths from influenza,	111	2.1	.28	.04
Deaths from anterior poliomyelitis,	29	.6	.07	.01
Deaths from tetanus,	5	.10	.013	.002
Deaths from glanders,	1	.02	.003	.0004
Deaths from anthrax,	1	.02	.003	.0004
Deaths from pellagra,	1	.02	.003	.0004
Deaths from smallpox,	2	.04	.005	.0008

II.

FATALITY OF CERTAIN INFECTIVE DISEASES.

Since the year 1891 the following statistics relative to the fatality of certain diseases have been gathered from the published reports of local boards of health. Until the passage of the law in 1893 this was the only source from which figures could be obtained on which to base the fatality of diseases as compared with cases. When the law (chapter 302, Acts of 1893) requiring local boards of health to report all cases of contagious diseases to the State Board of Health first went into effect very few returns were made, and it was not until after public notice had been given by the State Board to every board of health throughout the State that these returns came in with any regularity. The practice by the local boards of health of reporting cases of contagious diseases is now so well established, and the returns are so complete, it is no longer deemed necessary to continue the former method of basing the fatality of certain contagious diseases on the figures obtained through the annual reports of local boards, but, instead, to make use of the more complete returns as received from day to day at this office.

The diseases embraced in this summary in 1911 are diphtheria, scarlet fever, typhoid fever and measles.

The tabular list of cities and towns is omitted in this report. The summary of the figures for 1911 is as follows: —

Reported cases of diphtheria for the State,	6,998
Registered deaths from diphtheria,	563
Fatality (per cent.),	8.0
Reported cases of scarlet fever for the State,	6,173
Registered deaths from scarlet fever,	184
Fatality (per cent.),	3.0
Reported cases of typhoid fever for the State,	2,238
Registered deaths from typhoid fever,	302
Fatality (per cent.),	13.5
Reported cases of measles for the State,	16,094
Registered deaths from measles,	158
Fatality (per cent.),	1.0

The following table presents the summary of these statistics for the twenty-one years 1891–1911: —

Reported Cases of Infective Diseases in Massachusetts.

Diphtheria.

[Pre-Antitoxin Period.]

	1891.	1892.	1893.	1894.	Total.
Reported cases,	2,444	3,033	2,919	4,936	13,332
Deaths,	575	891	926	1,376	3,768
Fatality (per cent.),	23.5	29.2	31.7	27.9	28.3

Diphtheria.

[Antitoxin Period.]

	1910.	1911.	Total 1895–1911.
Reported cases,	7,390	6,998	128,178
Deaths,	679	563	14,081
Fatality (per cent.),	9.2	8.0	11.0

Reported Cases of Infective Diseases in Massachusetts — Concluded.

Scarlet Fever.

	1910.	1911.	Total 1891-1911.
Reported cases,	7,882	6,173	118,461
Deaths,	254	184	5,653
Fatality (per cent.),	3.2	3.0	4.7

Typhoid Fever.

	1910.	1911.	Total 1891-1911.
Reported cases,	3,452	2,238	55,107
Deaths,	411	302	9,167
Fatality (per cent.),	11.9	13.5	16.6

Measles.

	1910.	1911.	Total 1891-1911.
Reported cases,	18,794	16,094	210,963
Deaths,	240	158	2,870
Fatality (per cent.),	1.3	1.0	1.4

In the foregoing tables the statistics relating to diphtheria have been arranged in two periods, which may properly be called the pre-antitoxin and the antitoxin periods, since antitoxin came into general use in the State about the beginning of the year 1895. For the latter period the figures for 1910 and 1911 are given and the total for the seventeen years 1895 to 1911, inclusive. The mean fatality in the former period (1891–1894) was 28.3 per cent. (ratio of deaths to cases), and in the latter period (1895–1911) it was 11.0 per cent., or less than half as large.

III.

OFFICIAL RETURNS OF NOTIFIED DISEASES DANGEROUS TO THE PUBLIC HEALTH FOR THE YEAR ENDED DEC. 31, 1911.

The figures presented in the following summary are those of the official returns of diseases "dangerous to the public health," made to the State Board of Health during the year ended Dec. 31, 1911, under the provisions of chapter 75 of the Revised Laws. In this act no disease is specified as being "dangerous to the public health" except smallpox. Hence the State Board deemed it necessary to indicate the diseases which should be included in the meaning of the term "dangerous to the public health." They are the following: actinomycosis, anterior poliomyelitis, Asiatic cholera, cerebro-spinal meningitis, diphtheria, glanders, leprosy, malignant pustule, measles, ophthalmia neonatorum, scarlet fever, smallpox, tetanus, trachoma, trichinosis, tuberculosis, typhoid fever, typhus fever, varicella, whooping cough, yellow fever.

The whole number of cases of infective diseases reported to the Board in the year ended Dec. 31, 1911, under the provisions of this act, was 47,342, which was divided chiefly as follows: —

Reported cases of smallpox,	11
Reported cases of scarlet fever,	6,173
Reported cases of diphtheria,	6,998
Reported cases of typhoid fever,	2,238
Reported cases of measles,	16,094
Reported cases of cerebro-spinal meningitis,	150
Reported cases of anterior poliomyelitis,	232
Total,	31,896

The summary for the eighteen years and four months 1893–1911 is as follows: —

	Reported Cases of —							
	Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Anterior Poliomyelitis.	Totals.
1893 (four months only),	35	2,914	1,109	1,525	1,503	-	-	7,066
1894,	181	6,731	4,178	2,372	2,133	-	-	15,595
1895,	1	6,194	7,806	2,438	4,868	-	-	21,307
1896,	5	3,801	8,515	2,637	6,362	-	-	21,320
1897,	18	5,495	7,613	2,104	12,695	-	-	27,925
1898,	10	3,667	3,980	2,196	4,478	-	-	14,331
1899,	105	5,349	7,134	2,776	12,355	-	-	27,719
1900,	104	6,396	12,641	2,967	10,507	-	-	32,615
1901,	773	4,356	9,793	2,689	9,398	-	-	27,009
1902,	2,314	4,613	7,036	2,721	17,249	-	-	33,933
1903,	422	5,877	6,888	2,955	9,430	-	-	25,572
1904,	100	4,100	6,772	2,605	12,511	-	-	26,088
1905 (11 months),	44	3,594	5,059	2,794	6,107	455	-	18,053
1906 (Dec. 1, 1905–Nov. 30, 1906).	35	5,162	7,967	3,093	17,048	291	-	33,596
1907,	164	7,860	9,098	2,350	5,688	428	-	25,588
1908,	16	7,833	8,939	3,639	21,745	205	-	42,377
1909 (Dec. 1, 1908–Dec. 31, 1909).	21	8,036	8,795	2,945	15,857	143	-	35,797
1910,	156	7,882	7,390	3,452	18,794	153	654	38,481
1911,	11	6,173	6,998	2,238	16,094	150	232	31,896
Totals,	4,515	106,033	137,711	50,496	204,822	1,825	886	506,288

By months these diseases were reported as follows: —

Cases of Infective Diseases reported to the State Board of Health by Months for the Year ended Dec. 31, 1911.

Months.	Small-pox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Anterior Poliomyelitis.
January, . . .	-	701	1,194	98	1,196	6	11
February, . . .	-	671	589	86	1,323	19	2
March, . . .	-	762	548	111	2,008	16	9
April, ...	1	670	524	80	2,686	23	8
May, ...	4	660	468	106	3,402	13	7
June, ...	1	417	593	114	2,230	10	8
July, ...	-	238	312	185	849	12	17
August, . . .	-	207	353	346	237	11	61
September, . . .	1	297	471	455	159	8	50
October, . . .	-	474	677	321	308	10	37
November, . . .	2	524	593	203	598	10	16
December, . . .	2	552	676	133	1,098	12	6
Totals, . . .	11	6,173	6,998	2,238	16,094	150	232[1]

[1] This figure was increased to 260 by the special investigation of anterior poliomyelitis carried on during the year.

The following table is introduced for the purpose of facilitating the comparison of the seasonal prevalence of the diseases named in the table, in different years. By means of the method employed, the errors due to the difference in the length of the months are eliminated. The figures should be read as follows: for example, the mean daily number of reported cases of diphtheria throughout the year, Jan. 1, 1911, to Dec. 31, 1911, was 19.2; of scarlet fever, 16.9; of typhoid fever, 6.1; and of measles, 44.1. During the month of January the mean daily number of reported cases of these diseases was: for diphtheria, 38.5; scarlet fever, 22.6; typhoid fever, 3.2; and for measles, 38.6 (see columns marked A). Assuming a standard of 10 as a daily mean throughout the year for each disease, the ratios for January were as follows: diphtheria, 20.1; scarlet fever, 13.4; typhoid fever, 5.2; and measles, 8.8 (see columns marked B). So that for each 10 cases of diphtheria reported as a daily mean throughout the year ended Dec. 31, 1911, there were 20.1 in January, 10.9 in February, 9.2 in March, etc.

From this table it appears that the maximum prevalence of diphtheria was in January and the minimum in July. February, June, October, November and December were also above the mean in intensity of prevalence.

The prevalence of scarlet fever was above the mean in January, February, March, April, May, November and December, and below it in the remaining months. The maximum occurred in March and the minimum in August.

Typhoid fever was below the mean in the intensity of its prevalence in the months of January, February, March, April, May, June, July and December, the maximum occurring in September.

The prevalence of measles was above the mean in the months of February, March, April, May and June, and below it in the remaining months, the maximum occurring in May and the minimum in September.

Certain Infective Diseases. — Seasonal Intensity of Prevalence.

MONTHS.	DIPHTHERIA.			SCARLET FEVER.			TYPHOID FEVER.			MEASLES.		
	1911.		1910.	1911.		1910.	1911.		1910.	1911.		1910.
	A	B	B	A	B	B	A	B	B	A	B	B
	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.
January,	38.5	20.1	13.0	22.6	13.4	13.1	3.2	5.2	3.7	38.6	8.8	10.6
February,	21.0	10.9	12.1	24.0	14.2	11.5	3.1	5.1	3.7	47.3	10.7	16.6
March,	17.7	9.2	9.5	24.6	14.6	10.9	3.6	5.9	5.1	64.8	14.7	19.4
April,	17.5	9.1	10.5	22.3	13.2	21.1	2.7	4.4	5.2	89.5	20.3	21.9
May,	15.1	7.9	9.8	21.3	12.6	18.1	3.4	5.6	4.8	109.7	24.9	21.2
June,	19.8	10.3	9.2	13.9	8.2	9.4	3.8	6.2	4.9	74.3	16.8	14.3
July,	10.1	5.3	6.9	7.7	4.6	5.1	6.0	9.8	7.1	27.4	6.2	5.3
August,	11.4	5.9	6.8	6.7	4.0	3.8	11.2	18.4	27.3	7.6	1.7	1.4
September,	15.7	8.2	9.0	9.9	5.9	5.0	15.2	24.9	23.5	5.3	1.2	0.5
October,	21.8	11.4	10.9	15.3	9.1	6.7	10.4	17.0	17.7	9.9	2.2	1.3
November,	19.8	10.3	10.6	17.5	10.4	7.4	6.8	11.1	10.7	19.6	4.4	2.7
December,	21.8	11.4	12.1	17.8	10.5	8.0	4.3	7.0	5.2	35.4	8.0	5.5
Mean,	19.2	10.0	10.0	16.9	10.0	10.0	6.1	10.0	10.0	44.1	10.0	10.0

Cases of Infective Diseases reported to the State Board of Health from 305 Cities and Towns for the Year ended Dec. 31, 1911.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Abington,	1	22	11	1	1	1	-	5	-	-
Acton,	3	2	2	1	1	-	-	-	-	-
Acushnet,	5	11	1	2	-	-	-	-	1	-
Adams,	30	62	5	8	5	-	-	10	-	1
Agawam,	7	2	8	-	-	-	-	-	-	-
Amesbury,	5	2	8	4	7	-	-	-	-	1
Amherst,	2	-	5	3	3	-	-	2	-	-
Andover,	1	18	28	9	3	-	-	-	4	1
Arlington,	28	113	26	6	15	-	-	3	8	1
Ashburnham,	2	1	-	-	1	-	-	-	-	-
Ashland,	-	-	1	1	-	-	-	-	-	-
Athol,	25	6	28	5	9	-	-	6	8	1
Attleborough,	6	43	65	43	24	-	-	29	18	1
Auburn,	2	25	9	4	1	-	-	12	-	-
Avon,	2	50	2	-	1	-	-	11	2	-
Ayer,	1	8	2	-	-	-	-	-	-	-
Barnstable,	-	30	23	1	2	-	-	67	33	-
Barre,	1	1	1	2	2	-	-	-	2	-
Becket,	3	28	-	4	3	-	-	-	1	-
Bedford,	7	1	3	3	1	-	-	-	-	-
Belchertown,	3	2	-	-	-	-	-	-	-	-
Bellingham,	2	-	9	-	-	-	-	-	-	-
Belmont,	2	-	4	-	-	-	-	-	-	3
Berkley,	-	-	1	-	-	-	-	-	-	-
Berlin,	9	3	1	-	-	-	-	-	-	-
Beverly,	14	317	36	22	12	-	-	80	7	-
Billerica,	3	2	9	-	-	-	-	-	2	-
Blackstone,	51	-	7	2	2	-	-	-	-	1
Blandford,	1	-	-	1	-	-	-	-	-	-
Bolton,	-	2	-	-	-	-	-	-	-	-
Boston,	2,121	4,229	1,562	472	3,179	53	1	1,232	838	26
Bourne,	2	52	1	-	3	-	-	2	1	2
Boxborough,	3	1	5	-	-	-	-	-	-	-

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Boxford,	-	-	4	-	1	-	-	-	-	-
Boylston,	-	1	14	-	-	1	-	-	-	-
Braintree,	3	21	29	5	8	1	-	8	11	1
Brewster,	2	3	-	-	-	-	-	-	-	-
Bridgewater,	4	11	29	7	28	-	-	1	5	2
Brimfield,	2	2	4	-	2	-	-	-	-	-
Brockton,	27	352	105	27	129	2	-	91	38	-
Brookfield,	1	1	2	3	1	-	-	-	-	-
Brookline,	37	240	38	12	85	-	-	36	15	1
Buckland,	1	-	-	1	-	-	-	-	-	-
Burlington,	-	9	-	-	1	-	-	1	-	-
Cambridge,	397	602	222	55	268	7	-	206	113	10
Canton,	1	1	3	-	7	-	-	-	-	-
Carlisle,	1	-	3	1	-	-	-	-	-	-
Charlemont,	-	1	1	-	-	-	-	-	-	-
Charlton,	-	-	2	-	-	-	-	-	-	-
Chatham,	-	16	1	-	-	-	-	-	-	-
Chelmsford,	10	2	17	-	-	-	-	-	1	2
Chelsea,	108	330	138	23	87	-	-	44	57	2
Chester,	6	1	1	-	-	-	-	-	-	-
Chesterfield,	-	4	-	-	2	-	-	-	2	-
Chicopee,	54	48	41	44	38	2	-	13	9	-
Chilmark,	-	1	-	-	-	-	-	-	-	-
Clinton,	20	3	6	4	20	1	-	5	2	1
Cohasset,	-	218	-	2	8	-	-	3	2	1
Colrain,	-	62	1	1	-	-	-	4	6	-
Concord,	8	12	5	1	8	-	-	14	5	-
Conway,	-	-	-	-	-	-	-	-	1	-
Dalton,	5	38	11	-	5	-	-	2	-	-
Dana,	-	5	-	-	-	-	-	-	-	1
Danvers,	3	19	15	3	20	1	-	28	9	1
Dartmouth,	5	11	6	8	3	-	-	-	1	-
Dedham,	12	3	12	1	12	1	-	3	-	-
Deerfield,	4	21	3	-	1	-	-	-	-	1

Cases of Infective Diseases, etc. — Continued.

	Dipthheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Dennis,	-	2	2	-	1	1	-	-	-	-
Dighton,	10	-	23	1	3	-	-	-	-	-
Douglas,	-	-	6	-	1	-	-	-	4	-
Dover,	1	-	-	-	-	-	-	-	-	-
Dracut,	3	-	6	-	-	-	-	-	-	-
Dudley,	2	-	1	-	-	-	-	-	1	-
Dunstable,	-	-	1	-	-	-	-	-	-	-
Duxbury,	2	2	3	-	-	-	-	-	-	-
East Bridgewater,	4	4	10	10	17	1	-	-	-	-
East Longmeadow,	-	83	1	-	-	-	-	-	-	-
Easthampton,	12	-	-	9	3	-	-	-	-	1
Easton,	1	-	3	3	1	-	-	-	-	1
Egremont,	-	2	-	-	-	-	-	-	-	-
Erving,	-	29	-	5	2	-	-	7	-	-
Essex,	-	13	-	3	-	-	-	-	-	-
Everett,	66	124	56	13	69	3	-	19	20	-
Fairhaven,	2	-	2	9	2	-	-	-	3	-
Fall River,	130	499	131	91	235	2	-	121	21	13
Falmouth,	-	33	-	1	4	-	-	35	7	-
Fitchburg,	659	28	45	45	78	4	-	22	16	1
Florida,	5	11	-	1	-	-	-	-	-	-
Foxborough,	11	21	1	8	-	-	-	-	2	-
Framingham,	15	16	18	10	10	-	-	11	6	1
Franklin,	3	3	22	-	2	-	-	-	-	-
Freetown,	-	-	2	-	1	-	-	-	-	1
Gardner,	17	6	4	6	20	-	-	6	1	-
Georgetown,	-	1	2	1	-	-	-	-	2	-
Gill,	5	31	4	1	-	-	-	-	-	-
Gloucester,	29	38	33	12	38	-	-	15	12	1
Grafton,	-	-	3	4	-	-	-	1	-	-
Granville,	-	4	-	-	-	-	-	-	-	-
Great Barrington,	3	11	10	4	4	-	-	3	2	-
Greenfield,	7	293	12	7	4	1	-	-	3	2
Groton,	-	-	1	-	-	-	-	-	-	-

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Groveland,	2	1	9	2	1	-	-	6	-	-
Hadley,	-	3	1	-	1	-	-	-	-	-
Hamilton,	1	-	-	-	-	-	-	-	-	1
Hampden,	1	25	2	-	-	-	-	-	-	-
Hanover,	-	10	-	-	2	-	-	-	-	-
Hanson,	-	9	19	1	2	-	-	-	2	-
Hardwick,	7	12	4	3	9	-	-	-	5	1
Harvard,	2	-	-	-	1	-	-	-	-	-
Harwich,	-	1	-	2	2	-	-	-	-	-
Hatfield,	-	10	3	-	1	-	-	-	3	-
Haverhill,	119	72	117	50	102	2	-	84	76	5
Hawley,	1	-	1	-	-	-	-	-	-	-
Heath,	-	12	-	-	-	-	-	-	-	-
Hingham,	3	-	5	-	-	-	-	-	-	-
Hinsdale,	-	-	2	-	-	-	-	-	-	-
Holbrook,	-	5	12	-	5	-	-	3	2	-
Holden,	1	6	-	7	4	-	-	-	-	-
Holliston,	2	-	1	-	-	-	-	-	-	-
Holyoke,	68	46	132	28	64	1	2	6	8	-
Hopedale,	3	-	1	-	-	-	-	-	-	-
Hopkinton,	-	31	1	-	2	-	-	7	26	-
Hubbardston,	-	-	-	-	-	-	-	1	-	-
Hudson,	2	1	2	3	8	-	-	60	3	-
Hull,	2	7	11	4	-	-	-	9	-	-
Huntington,	1	2	1	1	-	-	-	-	-	-
Hyde Park,	14	39	20	5	12	-	-	19	11	2
Ipswich,	9	36	25	12	13	-	-	-	-	-
Kingston,	1	-	2	1	-	-	-	-	-	-
Lakeville,	-	-	1	-	-	-	-	-	-	-
Lancaster,	1	3	3	-	5	-	-	18	-	-
Lawrence,	112	248	115	34	126	4	1	8	50	2
Lee,	12	55	7	1	5	-	-	-	3	-
Leicester,	1	-	-	-	-	-	-	-	-	-
Lenox,	15	43	1	1	1	-	-	2	-	-

Cases of Infective Diseases, etc. — Continued.

	Dipthheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Leominster, ...	15	16	34	6	26	-	-	30	16	1
Lexington, ...	5	92	4	3	2	-	-	-	-	1
Leyden, ...	-	6	-	-	-	-	-	-	-	-
Longmeadow, . . .	2	-	1	-	-	-	-	-	-	-
Lowell, ...	155	167	225	62	143	15	-	16	21	15
Ludlow, ...	4	5	4	-	-	-	-	-	-	-
Lunenburg, ...	1	3	-	2	1	-	-	53	-	-
Lynn, ...	164	388	196	39	188	3	-	93	54	4
Lynnfield, ...	-	1	-	-	-	-	-	-	-	-
Malden, ...	66	448	113	43	95	-	-	19	32	7
Manchester, ...	2	4	1	5	-	-	-	-	2	-
Mansfield, ...	10	3	5	1	2	-	-	-	5	1
Marblehead, . . .	5	24	59	2	1	-	-	1	9	1
Marion, ...	-	1	3	-	3	-	-	-	-	-
Marlborough, . . .	30	3	9	11	15	-	-	-	1	-
Marshfield, ...	-	2	1	-	-	-	-	5	1	-
Mattapoisett, . . .	-	3	1	1	2	-	-	-	-	-
Maynard, ...	12	6	4	3	3	-	-	-	-	-
Medfield, ...	7	2	-	-	-	-	-	-	-	-
Medford, ...	51	106	32	9	30	-	-	46	30	5
Medway, ...	4	-	2	1	-	-	-	-	7	-
Melrose, ...	19	128	33	6	14	-	-	39	40	1
Merrimac, ...	2	-	1	-	-	-	-	-	-	-
Methuen, ...	12	27	12	4	6	-	-	2	-	1
Middleborough, . . .	5	8	16	1	4	1	-	4	3	1
Middlefield, ...	1	2	1	-	-	-	-	-	-	-
Milford, ...	2	-	5	6	11	-	-	-	-	-
Millbury, ...	6	145	6	8	4	-	-	-	3	-
Millis, ...	1	5	12	-	-	-	-	-	-	-
Milton, ...	11	33	18	5	9	-	-	25	24	-
Monroe, ...	4	1	-	-	-	-	-	1	-	-
Monson, ...	1	43	6	2	-	-	-	1	-	-
Montague, ...	18	46	5	-	2	-	-	-	-	-
Monterey, ...	-	22	-	-	-	-	-	-	-	-

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Nahant, ...	8	-	-	2	-	-	-	-	-	1
Nantucket, ...	-	4	5	-	-	-	-	-	-	-
Natick, ...	5	-	4	4	-	-	-	-	-	-
Needham, ...	6	6	4	-	6	-	1	2	-	-
New Ashford, . . .	-	-	1	-	-	-	-	-	-	-
New Bedford, . . .	89	138	131	123	253	5	-	141	79	7
New Braintree, . . .	-	1	-	-	-	-	-	2	-	-
New Marlborough, . .	-	-	1	1	-	-	-	-	-	-
New Salem, ...	-	2	-	1	-	-	-	-	-	-
Newbury, ...	1	-	1	2	3	-	-	-	-	-
Newburyport, . . .	20	11	5	9	24	2	-	97	12	-
Newton, ...	31	373	66	25	62	1	1	32	106	5
Norfolk, ...	3	1	1	-	-	-	-	-	-	-
North Adams, . . .	39	42	12	24	24	1	-	7	2	9
North Andover, . . .	1	11	4	3	2	-	-	-	2	-
North Attleborough, . .	13	5	13	9	3	-	-	-	18	-
North Brookfield, . .	-	-	14	2	-	-	-	-	-	-
North Reading, . . .	1	-	1	1	-	-	-	-	-	-
Northampton, . . .	46	21	21	16	36	4	-	30	28	1
Northborough, . . .	2	103	1	1	-	-	-	-	3	-
Northbridge, . . .	12	10	7	1	7	-	-	-	-	-
Northfield, ...	-	10	2	1	-	-	-	-	-	-
Norton, ...	-	-	1	-	1	-	-	-	-	-
Norwell, ...	-	18	1	4	1	-	-	-	-	-
Norwood, ...	41	272	8	5	6	2	-	38	2	-
Oak Bluffs, ...	-	-	-	-	-	1	-	-	2	-
Orange, ...	2	-	1	-	1	-	-	-	-	-
Orleans, ...	-	1	1	-	-	-	-	-	-	-
Oxford, ...	2	84	4	2	1	-	-	21	3	-
Palmer, ...	30	6	6	5	5	-	-	3	6	-
Peabody, ...	20	208	27	4	22	-	-	43	21	1
Pelham, ...	1	-	-	-	-	-	-	-	-	-
Pembroke, ...	-	4	6	-	1	-	-	-	-	-
Pepperell, ...	3	92	9	-	2	-	-	-	-	1

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Petersham,	-	54	3	1	-	-	-	6	-	-
Phillipston,	-	4	-	-	-	-	-	2	-	-
Pittsfield,	74	130	27	25	83	2	-	22	24	2
Plainfield,	-	-	-	1	1	-	-	-	-	-
Plainville,	-	-	1	-	-	-	-	-	-	-
Plymouth,	8	2	13	7	16	1	-	-	-	1
Plympton,	-	2	2	1	-	-	-	-	-	-
Princeton,	-	2	2	-	-	-	-	1	-	-
Provincetown,	12	-	-	2	1	-	-	-	-	-
Quincy,	78	304	149	24	36	1	1	36	29	1
Randolph,	3	6	7	3	1	-	-	-	-	-
Reading,	5	22	19	1	-	-	-	-	-	-
Rehoboth,	-	1	1	1	-	-	-	-	-	-
Revere,	31	9	31	4	25	-	-	-	-	1
Rochester,	5	-	2	-	1	-	-	-	-	-
Rockland,	2	316	24	3	10	-	-	-	5	1
Rockport,	2	43	9	2	7	-	-	2	-	-
Rowe,	2	1	1	-	-	-	-	-	-	-
Rowley,	1	1	7	2	1	-	-	-	-	-
Royalston,	1	-	1	-	-	-	-	-	-	1
Russell,	-	34	3	1	-	-	-	-	-	-
Rutland,	-	1	-	-	-	-	-	-	-	-
Salem,	92	770	36	32	73	2	-	133	80	1
Salisbury,	-	1	1	1	-	-	-	-	-	-
Saugus,	9	42	4	9	9	2	-	23	7	-
Savoy,	-	-	-	-	-	1	-	-	-	-
Scituate,	-	-	1	1	1	-	-	-	-	-
Seekonk,	-	-	4	-	2	-	-	-	-	-
Sharon,	4	5	13	-	6	-	-	3	-	-
Sheffield,	-	1	-	-	1	-	-	23	-	-
Shelburne,	1	3	1	-	-	-	-	-	1	-
Sherborn,	-	1	-	-	1	-	-	1	-	-
Shrewsbury,	-	-	2	-	-	-	-	-	-	-
Shutesbury,	-	-	1	-	-	-	-	-	-	-

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Somerset,	3	-	3	2	1	-	-	-	-	-
Somerville,	192	376	112	49	172	2	1	23	17	12
South Hadley,	-	17	2	1	1	-	-	-	1	-
Southborough,	1	2	-	1	-	-	-	-	-	-
Southbridge,	7	2	8	12	2	1	-	-	4	-
Southwick,	-	2	-	-	-	-	-	-	-	-
Spencer,	3	1	-	2	-	-	-	-	-	-
Springfield,	134	532	179	75	165	-	-	154	117	10
Sterling,	2	-	5	-	-	-	-	-	-	-
Stockbridge,	-	2	-	-	4	-	-	-	-	2
Stoneham,	2	8	13	2	1	-	-	-	-	-
Stoughton,	19	45	10	8	8	-	-	-	-	-
Stow,	3	-	-	1	1	-	-	-	-	-
Sturbridge,	1	1	-	1	-	-	-	-	-	-
Sudbury,	-	-	5	-	-	-	-	9	-	1
Sutton,	-	4	2	2	-	-	-	2	-	-
Swampscott,	3	20	9	7	7	-	-	7	7	-
Swansea,	1	3	1	-	3	-	-	-	-	-
Taunton,	50	4	44	20	28	1	1	41	20	-
Templeton,	3	6	3	-	4	-	-	10	2	-
Tewksbury,	1	24	-	1	1	-	-	-	8	5
Tisbury,	-	1	-	5	-	-	-	3	-	-
Topsfield,	-	17	-	-	1	-	-	5	-	-
Townsend,	-	-	2	1	-	-	-	-	-	-
Truro,	1	-	-	-	-	-	-	-	-	-
Tyngsborough,	6	-	-	1	-	-	-	-	-	-
Upton,	-	1	2	1	2	-	-	18	2	-
Uxbridge,	8	33	1	2	1	-	-	-	1	-
Wakefield,	19	217	9	3	1	-	1	1	-	-
Walpole,	11	20	16	4	8	2	-	5	12	-
Waltham,	51	88	36	28	41	-	-	32	10	1
Ware,	12	50	-	-	6	-	-	3	7	2
Wareham,	-	3	28	2	10	-	-	5	1	-
Warren,	5	-	-	2	2	-	-	-	-	1

Cases of Infective Diseases, etc. — Concluded.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.	Anterior Poliomyelitis.
Watertown,	35	29	19	4	6	-	-	8	7	1
Wayland,	-	-	9	3	-	-	-	-	1	1
Webster,	18	-	2	2	-	-	-	-	-	-
Wellesley,	14	11	26	10	4	-	-	4	4	-
Wellfleet,	1	-	-	-	-	-	-	-	-	-
West Boylston,	-	-	3	-	-	-	-	-	-	1
West Bridgewater,	2	-	3	-	-	-	-	-	-	-
West Brookfield,	-	1	-	-	1	-	-	-	1	-
West Springfield,	14	-	22	2	-	-	-	-	-	-
West Stockbridge,	-	-	-	1	-	-	-	-	-	1
Westborough,	3	11	1	3	1	-	-	-	-	-
Westfield,	27	9	33	25	21	-	-	2	3	4
Westford,	2	3	-	1	4	-	-	-	-	1
Westhampton,	-	-	-	-	1	-	-	-	-	-
Westminster,	3	2	6	-	-	-	-	-	-	-
Weston,	-	7	3	-	3	-	-	13	9	-
Westport,	-	3	5	-	-	1	-	33	21	1
Westwood,	-	-	1	-	-	-	-	-	-	-
Weymouth,	17	6	4	1	1	-	-	-	-	-
Whately,	-	-	-	1	-	-	-	-	-	-
Whitman,	4	21	30	2	8	-	-	-	1	-
Wilbraham,	2	-	5	13	1	-	-	-	-	-
Williamsburg,	1	14	-	1	1	6	-	-	1	-
Williamstown,	21	3	1	2	3	-	-	1	10	1
Wilmington,	1	8	2	-	-	-	-	-	-	-
Winchendon,	44	25	2	3	3	-	-	4	1	1
Winchester,	2	20	2	2	10	-	-	50	19	3
Windsor,	-	-	3	-	-	-	-	-	-	-
Winthrop,	29	201	11	5	4	-	1	3	34	3
Woburn,	34	35	17	16	14	1	-	22	4	11
Worcester,	444	248	463	134	358	3	-	69	48	5
Worthington,	-	2	-	-	-	-	-	-	-	-
Wrentham,	1	32	2	2	1	-	-	-	-	-
Yarmouth,	-	4	-	-	-	-	-	-	-	-
Totals,	6,998	16,094	6,173	2,238	7,031	150	11	3,911	2,542	232

Actinomycosis occurred in the following places: —

Boston,	3
Cambridge,	1
Lynn,	1
	5

Anthrax occurred in the following places: —

Lynn,	3
Norwood,	1
	4

Erysipelas occurred in the following places: —

Adams,	2
Chelsea,	3
Lynn,	9
North Adams,	2
Pittsfield,	1
Rockland,	1
Russell,	1
Salem,	5
Somerville,	2
Swansea,	1
Tisbury,	3
	30

Glanders occurred in the following place: —

Haverhill,	1

Leprosy occurred in the following place: —

Boston,	2

Malaria occurred in the following place: —

Boston,	25

Malignant pustule occurred in the following places: —

Lynn,	1
Revere,	1
	2

Meningitis other than cerebro-spinal occurred in the following places: —

Brockton,	3
Cambridge,	8
Chelsea,	2
Dartmouth,	1
Fall River,	1
Framingham,	1
Haverhill,	6
Hudson,	1
Leominster,	1
Lynn,	1
Mansfield,	1
Methuen,	1
New Bedford,	1
Newburyport,	1
Newton,	3
Norwood,	1
Pittsfield,	2
Salem,	1
Saugus,	1
Somerville,	1
Sterling,	1
Waltham,	1
	40

Mumps occurred in the following places: —

Adams,	1
Boston,	283
Brockton,	3
Chelsea,	14
Dalton,	3
Deerfield,	2
Erving,	1
Everett,	5
Fall River,	1
Falmouth,	5
Framingham,	2
Great Barrington,	1
Groton,	2
Heath,	1
Kingston,	1
Lynn,	8
North Attleborough,	1

Northfield,	1
Quincy,	3
Somerville,	2
Winthrop,	1
	341

Ophthalmia neonatorum occurred in the following places: —

Abington,	1
Adams,	2
Amesbury,	1
Amherst,	1
Attleborough,	4
Becket,	1
Beverly,	3
Boston,	1,006
Bridgewater,	3
Brockton,	11
Brookline,	3
Cambridge,	18
Canton,	1
Chelsea,	6
Chicopee,	2
Clinton,	1
Danvers,	1
Easthampton,	2
Easton,	1
Everett,	12
Fall River,	13
Falmouth,	1
Fitchburg,	4
Gardner,	1
Gloucester,	2
Greenfield,	1
Haverhill,	11
Holyoke,	2
Hudson,	2
Hull,	1
Hyde Park,	1
Lancaster,	1
Lawrence,	7
Leominster,	1
Lexington,	1
Lowell,	10
Lynn,	25
Malden,	17

Manchester,	1
Mansfield,	1
Marblehead,	1
Marlborough,	1
Medford,	6
Melrose,	3
Middleborough,	3
New Bedford,	21
Newburyport,	10
Newton,	11
North Adams,	1
Northbridge,	1
Norwood,	2
Palmer,	1
Pepperell,	1
Provincetown,	1
Quincy,	11
Revere,	3
Rockland,	1
Salem,	9
Saugus,	4
Somerville,	16
Spencer,	1
Springfield,	16
Sutton,	1
Swampscott,	2
Taunton,	5
Waltham,	28
Wareham,	1
Watertown,	1
Westfield,	4
Westhampton,	1
Winchester,	4
Winthrop,	3
Woburn,	1
Worcester,	14
	1,372

Tetanus occurred in the following places: —

Attleborough,	2
Beverly,	1
Boston,	14
Cambridge,	2
Chelsea,	1
East Bridgewater,	1

Leominster,	1
Marblehead,	1
New Bedford,	1
Newton,	1
Peabody,	2
Salem,	3
Springfield,	5
Taunton,	1
Worcester,	2
	38

Trachoma occurred in the following places: —

Boston,	17
Lynn,	1
Newton,	1
Worcester,	2
	21

Tuberculosis other than phthisis occurred in the following places: —

Bridgewater,	1
Brockton,	3
Cambridge,	11
Chelsea,	1
Clinton,	1
Concord,	1
Fall River,	14
Haverhill,	10
Hudson,	1
Lowell,	5
Malden,	1
New Bedford,	13
Newburyport,	1
Newton,	1
Pittsfield,	2
Quincy,	1
Salem,	7
Saugus,	1
Somerville,	2
Springfield,	1
Sutton,	1
Weston,	1
Worcester,	1
	81

List of Cities and Towns from which no Reports were received.

1. Cities.

None.

2. Towns having a Population of More than 5,000.

None.

3. Towns having a Population of More than 1,000 but Less than 5,000 in Each.

Carver,
Cheshire,
Clarksburg,
Edgartown,
Lincoln,
Littleton,
Middleton,
Raynham,
Sandwich,
Shirley,
Sunderland,
Wenham,
West Newbury. — 13.

4. Towns having Less than 1,000 Inhabitants.

Alford,
Ashby,
Ashfield,
Bernardston,
Cummington,
Eastham,
Enfield,
Gay Head,
Goshen,
Gosnold,
Granby,
Greenwich,
Halifax,
Hancock,
Holland,
Lanesborough,
Leverett,
Mashpee,
Mendon,
Montgomery,
Mount Washington,
Oakham,
Otis,
Paxton,
Peru,
Prescott,
Richmond,
Sandisfield,
Southampton,
Tolland,
Tyringham,
Wales,
Warwick,
Washington,
Wendell,
West Tisbury. — 36.

A supply of postal cards for the purpose of reporting infective diseases to the State Board of Health, as required by statute, will be forwarded to any local board of health on application to the secretary of the State Board, Room 145, State House, Boston.

IV.

OFFICIAL RETURNS OF DEATHS IN CITIES AND LARGE TOWNS (REVISED LAWS, CHAPTER 75, SECTION 12).

1911.

In the following summary, the statistics of deaths required by chapter 75, section 12, of the Revised Laws, are presented. These statistics are returned to the Board from each city and town which has, "according to the latest census, more than five thousand inhabitants."

The cities and towns which have contributed these returns for the year

1911 comprise the same list as for the year 1910. This list embraces all of the 33 cities and the towns having more than 5,000 inhabitants in each.

The list for the year 1911 includes 111 cities and towns. The total estimated population of this group of cities and towns in 1911 was 3,058,457, or about 89 per cent. of the total estimated population of the State. Hingham and Williamstown have again made returns, although their populations fell below 5,000 in 1910. In addition, the following towns, now near the 5,000 mark, have voluntarily made returns, although not required by law so to do: Lexington, Ludlow, Monson and Walpole.

The whole number of registered deaths in these cities and towns in 1911 was 46,634, and the death-rate, as calculated from the foregoing estimated population, was 15.25 per 1,000 of the living population, that of the previous year having been 16.04 per 1,000, and that of 1909, 15.92 per 1,000.

The death-rate for the year 1911 was lower than that of 1910, and considerably lower than the mean annual death-rate of the State for the fifty years ended Dec. 31, 1900, which was 19.22 per 1,000.

Sexes. — The number of deaths of males was 24,157, or 51.80 per cent. of the whole number of deaths whose sex was known; and the deaths of females were 22,474, or 48.19 per cent. There were 3 in which the sex was not stated in the returns.

Ages. — The deaths by four groups of ages were as follows. —

AGES.	Deaths, 1911.	PERCENTAGES OF ALL DEATHS.	
		1911.	1910.
Under 1 year, ...	9,572	20.54	22.05
1 to 20 years, ...	5,517	11.83	13.09
20 to 50 years, ...	10,794	23.16	22.52
50 and over, ...	20,730	44.47	42.34

Infant Mortality. — The deaths of infants under one year old were 9,572, or 20.54 per cent. of the total mortality, as compared with 22.05 per cent. in 1910. In the year 1900 the rate was 23; that of the five years 1907–11, respectively, constituted 21.55, 22.92, 21.63, 22.05 and 20.54 per cent. of the total mortality.

The deaths of children under five years old were 12,857, or 27.6 per cent. of the total mortality, as compared with 29.8 per cent. for the same age in 1910.

All of the percentages in the foregoing table were estimated upon the number of deaths of those whose ages were stated in the returns. The total number of deaths in which the age was not specified was 21; in 1910 it was 57.

Still-births. — The number of still-births was 3,194, and when compared with the total mortality (still-births included), this was 6.4 per cent. of the total deaths and still-births combined. In 1910 the percentage was 6.2.

Months and Quarters. — The number of deaths in each quarter of the year is shown in the following table: —

	Deaths, 1911.	Percentages.	
		1911.	1910.
First quarter,	12,767	27.38	26.48
Second quarter,	11,068	23.73	24.00
Third quarter,	12,436	26.67	25.81
Fourth quarter,	10,360	22.22	23.71
Total,	46,631	100.00	100.00

These percentages differ but little from the mean of several years. As in 1907, 1908, 1909 and 1910, the highest mortality was in the first quarter.

During the forty-year period (1856–95) the mortality was generally above the mean in the third quarters of the years and below it in the other three quarters.

The intensity of the seasonal death-rate is more accurately shown in the following table, the method employed being explained on page 615 in Section III. of these summaries, relating to disease notification. By this method the errors which are due to differences in the length of the months are eliminated.

Months.	Deaths in Each Month.	Mean Daily Deaths per Month, 1911.	Centesimal Ratio.	
			1911.	1910.
January,	4,214	135.9	106.3	104.2
February,	4,078	145.6	113.9	105.9
March,	4,475	144.4	113.0	111.6
April,	4,109	137.0	107.2	106.4
May,	3,884	125.3	98.0	93.1
June,	3,075	102.5	80.2	89.3
July,	4,975	160.5	125.6	107.0
August,	3,904	125.9	98.5	101.7
September,	3,557	118.6	92.8	98.0
October,	3,356	108.3	84.7	89.9
November,	3,324	110.8	86.7	91.2
December,	3,680	118.7	92.9	101.1
	-	127.8	100.0	100.0

The figures in the foregoing table indicate a departure in excess of the mean death-rate in January, February, March, April and July, while that of the remaining months was below the mean.

The mean maximum departure from the death-rate for each month for the period of twenty years 1856–75 was 32.9 per cent. in August, and the twenty-year period 1876–95 it was 20 per cent. in August, while that of August, 1911, was considerably below the mean, and those of February and July, the two months in which the death-rates were the highest, were, respectively, 13.9 and 25.6 per cent.

In the two years having the highest death-rates in Massachusetts in the past half-century or more (1849 and 1872) the maximum departures from the yearly means were, respectively, 83.4 per cent. in August, 1849, and 40 per cent. in August, 1872. That of January, 1890, the month in which the epidemic of influenza was at its maximum, was 43.4 per cent. above the mean.

The figures for 1911, when compared with those of earlier years in the past half-century, show a much greater uniformity in the seasonal mortality, since serious epidemics have not prevailed in the State either in the past year or in any of the years of the past decade.

Death-rates of Cities and Large Towns. — In Table II., last column, the death-rates of cities and towns having over 5,000 inhabitants are given. These death-rates are obtained by comparing the deaths in each city and town with the estimated population. They vary from a minimum of 8.7 in Norwood to 20.6 per 1,000 in Grafton.

The following cities and towns had death-rates above 19 per 1,000 in 1911: Grafton, 20.6; Plymouth, 20.2; Montague, 19.1.

Of the foregoing, Grafton had a death-rate above 19 per 1,000 in 1910.

The following cities and towns had death-rates less than 12 per 1,000 in 1911: Milton, 11.9; Palmer, 11.9; Ludlow, 11.8; Medford, 11.6; Whitman, 11.6; Danvers, 11.5; Methuen, 11.5; Bridgewater, 11.4; Newton, 11.4; Monson, 11.2; Quincy, 11.1; Melrose, 11.1; Everett, 11.0; Attleborough, 10.9; Brockton, 10.9; Dedham, 10.9; North Attleborough, 10.8; Wellesley, 10.7; Winthrop, 10.4; Watertown, 10.4; Southbridge, 10.1; Winchester, 9.9; Northbridge, 9.8; Walpole, 9.7; Revere, 9.5; North Andover, 9.5; Concord, 9.2; Westborough, 8.9; Norwood, 8.7. Of these, Bridgewater, Concord, Danvers, Everett, Medford, Norwood, Quincy, Watertown, Wellesley, Westborough, Whitman, Winchester and Winthrop had death-rates below 12 per 1,000 in 1910.

Death-rates of Certain Cities having a Population of More than 25,000. Mean Death-rates of the Seven Census Years 1870, 1875, 1880, 1885, 1890, 1895 1900, and for 1905, 1910 and 1911.

CITIES.	Mean Death-rates, 1870, 1875, 1880, 1885, 1890, 1895 and 1900.	Death-rate, 1905.	Death-rate, 1910.	Death-rate, 1911.
Boston,	23.3	18.5	17.3	17.1[1]
Worcester,	19.5	17.4	17.0	15.7[1]
Fall River,	22.8	20.2	18.5	17.5
Lowell,	21.8	20.0	19.8	17.7
Cambridge,	19.0	15.5	15.4	16.0
New Bedford,	20.7	17.2	18.8	17.0
Lynn,	17.4	16.2	13.1	12.5
Springfield,	19.0	15.2	16.7	15.3
Lawrence,	21.7	19.6	17.7	16.0
Somerville,	17.1	14.0	13.5	13.1
Holyoke,	22.2	16.3	17.8	15.2
Brockton,	15.8	12.7	12.4	10.9
Malden,	16.4	13.3	13.1	12.1
Haverhill,	17.2	15.5	17.0	13.9
Salem,	21.4	19.5	15.9	16.7
Newton,	14.3	13.1	12.2	11.4
Fitchburg,	16.4	13.1	13.4	12.8
Taunton,	19.7	21.8	23.4	20.5[1]
Everett,	15.4	13.9	11.0	11.0
Quincy,	17.1	13.1	11.7	11.1
Chelsea,	19.7	18.4	18.6	19.3[1]
Pittsfield,	17.5	16.6	17.7	16.6
Waltham,	15.0	13.7	14.0	13.8
Chicopee,	20.8	17.7	15.4	14.7
Gloucester,	20.6	14.8	16.0	14.3[2]

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[1] These figures for Boston, Chelsea, Worcester and Taunton include all deaths. By exclusion of deaths of nonresidents in Boston and deaths in public and private institutions in the other 3 cities, the death-rates would be reduced to 14.2 in Chelsea, 15.2 in Boston, 16.2 in Taunton and 14.5 in Worcester.

[2] Gloucester has been allowed to stand in this list, although it dropped below the 25,000 mark during the five years 1905–1910.

Causes of Death. — In Table III. the mortality of the cities and towns embraced in this summary is presented in absolute figures, classified according to the principal causes of death. The same figures are again presented in relative terms in Table IV., for the whole group of cities and towns combined. Two sets of figures are given in Table IV., in one of which the mortality from each principal cause of death is compared with the estimated population of the group for 1911, as well as for each of the last five years, and in the other with the total mortality of the group of cities and towns.

By this it appears that the general death-rate from all causes, as shown in the lower line at the left of the table, 152.47 per 10,000 living, or, as usually stated, 15.25 per 1,000 was lower than that of 1910, and lower than in the years 1909, 1908 and 1907, when it was 15.92, 16.40 and 17.46, respectively. The population comprised in these returns constitutes about 89 per cent. of that of the whole State.

The decline in the general death-rate during the year 1911 is chiefly due to a decrease in the relative number of deaths from infective diseases, more especially to the gastro-intestinal diseases of infancy and childhood.

The death-rate from each of the following causes was less than that of 1910: consumption, scarlet fever, diphtheria and croup, erysipelas, influenza, typhoid fever, cerebro-spinal meningitis, dysentery, cholera infantum, pneumonia, bronchitis, diseases of the heart, diseases of the brain and spinal cord and diseases of the kidneys. That of consumption, scarlet fever, diphtheria and croup, typhoid fever, cerebro-spinal meningitis, influenza, dysentery, pneumonia, bronchitis and diseases of the brain and spinal cord was also less than the death-rate from each of the same causes in any of the last five years.

The following table, first published in the report of 1899, presents the combined death-rate from eight of the principal infective diseases, and also shows that this combined death-rate in 1911 was less than that of any of the years embraced in this series of reports.

The diseases referred to are consumption, measles, scarlet fever, diphtheria, whooping cough, typhoid fever, puerperal fever and cholera infantum.

The combined death-rate per 10,000 of the population from these eight causes for the seventeen years (1895–1911) in the cities and towns included in this report (about seven-eighths of the total population of the State) was as follows: —

Combined Death-rate from Eight Principal Infective Diseases.

YEAR.	Combined Death-rate per 10,000.	YEAR.	Combined Death-rate per 10,000.
1895,	46.4	1904,	27.0
1896,	46.8	1905,	28.0
1897,	39.7	1906,	27.9
1898,	36.3	1907,	27.8
1899,	35.2	1908,	28.5
1900,	40.7	1909,	27.1
1901,	33.5	1910,	26.1
1902,	30.9	1911,	22.5
1903,	30.7		

The death-rate from consumption was lower in 1911 than in any year of record, being 11.11, as against 12.60 in 1910, 13.38 in 1909, 13.49 in 1908 and 15.50 in 1907.

The seasonal table which appeared in the earlier reports, presenting the deaths by months for each city and town and for the whole State, is omitted in the present report, since the details presented in this table are not of essential value. Its chief value consisted in the column of total figures for the State, which is retained essentially in the table on page 633.

The table of percentages of total mortality shown in Table IV. acts in a measure as a check or control in case of erroneous estimates of population.

The changes in the death-rate from consumption, typhoid fever and puerperal fever (see child-birth in report of 1896, page 804) were quite fully treated in the report of 1896. To these may be added the later comments on the changes in the death-rate from diphtheria, which appear in the figures of the past seventeen years.

The following preventable causes of death, consumption, measles, scarlet fever, diphtheria, whooping cough, typhoid fever, puerperal fever and cholera infantum, together constituted 27.2 per cent. of the total mortality in 1894, but had fallen off to 24.2, 24.2, 21.9, 21.1, 20.4, 22.3, 19.9, 19, 19, 17.5, 16.7, 16.8, 15.9, 17.4, 17.0, 16.3 and 14.7 in the seventeen succeeding years; while the principal acute lung diseases, diseases of the heart, brain, kidneys, cancer, suicide and accident had increased from 35.7 per cent. of the total mortality to 36.9, 36.9, 38.5, 39.2, 40.2, 38.6, 40.1, 42.7, 43, 45.7, 46.6, 45.6, 46.3, 46.7, 47.5, 50.3 and 49.4 in the same years.

These all combined constituted the greater part of the total mortality in each of the eighteen years 1894–1911, and of the diseases specified in the table entitled the "Balance of Mortality," in the annual report of 1896, page 812.

Table I.

Population of Cities and Large Towns, estimated for 1911.

Reporting Cities and Towns.	Population, 1911.	Reporting Cities and Towns.	Population, 1911.
Abington,	5,530	Arlington,	11,518
Adams,	13,137	Athol,	8,804
Amesbury,	10,105	Attleborough,	17,027
Amherst,	5,112	Belmont,	5,778
Andover,	7,435	Beverly,	19,423

TABLE I. — *Continued.*

REPORTING CITIES AND TOWNS.	Population, 1911.	REPORTING CITIES AND TOWNS.	Population, 1911.
Blackstone,	5,648	Ludlow,	5,161
Boston,	686,730	Lynn,	92,021
Braintree,	8,303	Malden,	45,800
Bridgewater,	7,875	Mansfield,	5,371
Brockton,	58,892	Marblehead,	7,364
Brookline,	28,756	Marlborough,	14,682
Cambridge,	106,386	Maynard,	6,506
Chelmsford,	5,161	Medford,	23,913
Chelsea,	32,452	Melrose,	16,015
Chicopee,	26,594	Methuen,	12,101
Clinton,	13,075	Middleborough,	8,479
Concord,	6,621	Milford,	13,254
Danvers,	9,476	Milton,	8,098
Dedham,	9,586	Monson,	4,841
Easthampton,	8,867	Montague,	6,866
Easton,	5,185	Natick,	9,917
Everett,	34,434	Needham,	5,174
Fairhaven,	5,297	New Bedford,	101,855
Fall River,	122,202	Newburyport,	15,004
Fitchburg,	38,868	Newton,	40,430
Framingham,	13,248	North Adams,	22,019
Franklin,	5,720	Northampton,	19,431
Gardner,	15,305	North Andover,	5,712
Gloucester,	24,398	North Attleborough,	9,899
Grafton,	5,836	Northbridge,	9,068
Great Barrington,	5,926	Norwood,	8,271
Greenfield,	10,702	Orange,	5,282
Haverhill,	45,492	Palmer,	8,781
Hingham,	4,994	Peabody,	16,306
Holyoke,	59,430	Pittsfield,	33,772
Hudson,	6,848	Plymouth,	12,356
Hyde Park,	15,714	Quincy,	33,641
Ipswich,	5,891	Reading,	5,845
Lawrence,	87,000	Revere,	19,595
Leominster,	18,322	Rockland,	7,056
Lexington,	4,996	Salem,	45,024
Lowell,	108,734	Saugus,	8,406

TABLE I. — *Concluded.*

REPORTING CITIES AND TOWNS.	Population, 1911.	REPORTING CITIES AND TOWNS.	Population, 1911.
Somerville,	78,935	Webster,	11,833
Southbridge,	12,937	Wellesley,	5,413
South Hadley,	4,894	Westborough,	5,460
Spencer,	6,740	Westfield,	16,580
Springfield,	92,370	West Springfield,	9,449
Stoneham,	7,242	Weymouth,	13,174
Stoughton,	6,387	Whitman,	7,446
Swampscott,	6,417	Williamstown,	3,708
Taunton,	34,958	Winchendon,	5,678
Wakefield,	11,646	Winchester,	9,522
Walpole,	5,070	Winthrop,	10,899
Waltham,	28,155	Woburn,	15,496
Ware,	8,810	Worcester,	149,844
Watertown,	13,225	Total,	3,058,457

TABLE II.

Total Deaths, Deaths by Sexes, Age Periods and Still-births in Cities and Towns having over 5,000 Inhabitants in Each with General Death-rates estimated for 1911.

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Abington, ...	98	55	43	-	3	10	2	1	1	2	-	1	4	4	3	8	12	16	20	14	-	17.72
Adams, ...	190	110	80	-	9	67	12	3	1	2	4	1	4	7	9	11	15	24	21	9	-	14.46
Amesbury, ...	154	75	79	-	6	28	4	-	1	-	2	3	4	6	5	13	15	25	27	21	-	15.24
Amherst, ...	77	37	40	-	4	7	-	-	2	-	3	2	1	2	5	6	6	17	10	16	-	15.06
Andover, ...	119	56	63	-	5	11	1	-	1	-	1	2	2	6	9	7	16	26	22	14	1	16.01
Arlington, ...	186	97	89	-	8	19	5	1	1	-	3	2	9	8	19	18	21	32	31	17	-	16.14
Athol, ...	122	58	63	1	15	24	5	3	1	2	1	-	2	6	8	8	11	19	23	9	-	13.85
Attleborough, ...	186	90	96	-	15	50	9	2	1	1	3	3	3	15	9	15	18	18	23	16	-	10.92
Belmont, ...	96	50	46	-	2	13	1	1	-	-	-	1	3	6	5	8	13	14	19	12	-	16.62
Beverly, ...	286	154	132	-	22	55	2	4	2	3	10	6	2	16	22	18	30	43	41	32	-	14.72
Blackstone, ...	93	40	53	-	3	15	3	1	-	2	4	2	-	1	9	6	14	15	14	6	1	16.47
Boston,[1]	11,759	6,216	5,543	-	715	2,245	476	179	127	93	214	122	217	813	1,154	1,360	1,432	1,582	1,146	599	-	15.16[2]
Braintree, ...	112	52	60	-	5	21	3	-	3	1	3	3	1	6	8	12	15	18	10	8	-	13.49
Bridgewater,[2]	90	47	43	-	9	17	1	2	1	1	1	-	1	4	6	7	11	15	10	18	-	11.43[2]
Brockton, ...	640	307	333	-	76	112	24	12	1	3	15	3	21	40	41	64	76	99	84	45	-	10.87
Brookline, ...	345	151	194	-	10	23	7	-	3	2	3	3	1	14	24	28	52	51	82	52	-	12.00

Cambridge, ...	1,708	868	835	-	89	340	63	40	25	20	47	30	42	93	147	148	183	207	195	123	-	16.01
Chelmsford, . . .	86	38	48	-	-	19	-	-	-	1	2	4	1	5	2	7	9	16	11	9	-	16.66
Chelsea,[4]	624	410	214	-	49	105	18	5	5	7	10	6	14	38	53	58	50	108	99	48	-	14.17[2]
Chicopee, . . .	390	196	194	-	34	142	24	9	7	5	5	7	7	23	20	30	24	35	30	20	2	14.66
Clinton, ...	183	98	85	-	9	23	6	1	1	-	2	-	6	10	22	18	16	34	25	19	-	13.99
Concord, ...	61	30	31	-	1	6	2	1	-	-	2	2	5	4	7	5	-	5	14	7	1	9.21
Danvers,[5] . . .	109	54	55	-	11	9	-	1	-	-	1	1	1	5	8	8	18	21	20	16	-	11.50[2]
Dedham, ...	104	48	56	-	12	9	5	4	1	1	2	2	2	3	8	8	9	16	17	16	1	10.85
Easthampton, . . .	140	75	65	-	10	36	6	1	3	-	2	1	2	8	9	11	11	23	17	10	-	15.79
Easton, ...	78	41	37	-	4	10	2	1	-	1	-	-	-	4	3	5	13	18	16	5	-	15.04
Everett, ...	377	174	203	-	40	53	10	7	3	3	7	6	4	23	33	34	41	65	54	34	-	10.95
Fairhaven, . . .	82	40	42	-	1	16	2	-	2	-	-	1	1	3	6	8	3	17	14	7	2	15.48
Fall River, . . .	2,135	1,117	1,018	-	185	809	165	55	27	16	36	30	35	104	137	147	176	203	137	58	-	17.47
Fitchburg, . . .	498	239	259	-	45	116	21	12	7	6	6	6	8	42	34	27	53	66	54	40	-	12.81
Framingham, . . .	182	103	79	-	20	31	4	2	2	-	3	1	4	12	18	21	19	23	26	16	-	13.74
Franklin, ...	74	38	36	-	5	8	3	1	-	-	1	3	2	4	3	5	10	6	20	8	-	12.93
Gardner, ...	188	99	89	-	13	47	8	2	-	1	4	2	1	16	8	12	23	27	24	13	-	12.28
Gloucester, . . .	348	174	174	-	22	57	10	8	2	2	9	5	9	24	25	19	43	59	42	34	-	14.26
Grafton, ...	120	62	58	-	4	16	5	2	-	2	1	4	1	4	13	11	12	19	22	8	-	20.56
Great Barrington, . .	82	38	44	-	2	13	3	1	1	-	2	2	1	1	8	7	4	10	15	14	-	13.84
Greenfield, . . .	155	72	83	-	8	22	12	5	3	1	4	2	3	10	7	10	11	28	22	13	2	14.48
Haverhill, . . .	634	312	322	-	77	78	23	7	3	1	19	5	11	37	58	53	79	90	91	79	-	13.94
Hingham, . . .	83	34	49	-	2	8	-	1	-	1	-	-	-	3	4	7	7	19	16	17	-	16.62

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[1] Nonresidents, 1,349, included.

[2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being nonresidents.

[3] State Farm, 140 additional.

[4] Soldiers' Home and Marine and Naval hospitals, 164, included.

[5] Insane asylum, 188 additional.

TABLE II. — *Continued.*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Holyoke, ...	902	466	436	-	69	303	33	8	12	4	20	10	13	61	50	71	90	107	90	30	-	15.18
Hudson, ...	83	41	42	-	3	13	1	1	1	-	-	-	2	3	2	6	12	14	19	9	-	12.12
Hyde Park, . . .	212	103	109	-	20	33	4	1	4	5	4	2	8	13	5	17	29	35	28	24	-	13.49
Ipswich, ...	101	56	45	-	4	23	5	1	1	-	-	-	3	6	5	6	5	14	18	13	1	17.14
Lawrence, . . .	1,391	707	684	-	133	426	104	28	16	9	19	20	20	87	118	125	119	140	110	50	-	15.99
Leominster, . . .	287	142	145	-	10	51	2	3	2	-	5	3	3	15	22	24	26	48	58	25	-	15.66
Lexington, . . .	61	33	28	-	2	12	1	-	1	1	3	-	2	-	1	7	4	5	13	10	1	12.21
Lowell, ...	1,925	985	940	-	124	484	97	36	21	10	33	18	36	127	153	162	203	237	197	111	-	17.70
Ludlow, ...	61	29	32	-	3	21	2	-	3	3	5	1	1	4	2	6	2	5	3	3	-	11.82
Lynn, ...	1,147	576	571	-	118	202	40	13	7	13	12	9	22	80	90	124	136	155	149	93	2	12.46
Malden, ...	554	287	267	-	41	89	10	11	2	2	12	13	13	36	35	51	68	82	79	51	-	12.10
Mansfield, . . .	76	43	33	-	5	7	1	-	1	-	1	1	2	3	11	8	3	12	16	10	-	14.15
Marblehead, . . .	110	54	56	-	2	10	4	-	-	-	-	-	-	3	4	7	8	23	29	22	-	14.94
Marlborough, . . .	223	116	107	-	9	26	3	3	1	-	5	2	3	13	11	23	30	47	35	21	-	15.19
Maynard, . . .	88	50	38	-	12	28	7	1	4	-	3	1	1	2	10	5	11	8	4	3	-	13.52
Medford, ...	277	127	150	-	6	34	5	4	2	2	3	2	9	11	17	26	31	43	42	46	-	11.58
Melrose, ...	177	82	95	-	9	18	1	3	-	-	-	1	2	6	10	12	15	36	52	21	-	11.05
Methuen, ...	139	61	78	-	16	24	2	2	-	1	4	1	5	6	6	10	10	20	32	16	-	11.49

Middleborough, . . .	104	59	45	-	2	13	4	1	-	1	-	-	1	5	4	7	8	16	30	14	-	12.37
Milford, ...	213	131	82	-	16	31	3	3	1	1	1	5	6	16	20	25	27	34	31	9	-	16.07
Milton, ...	97	41	56	-	3	9	2	-	-	-	5	1	4	4	7	6	11	17	18	13	-	11.98
Monson,[1]	54	29	25	-	2	6	2	-	-	-	-	-	2	3	5	4	6	16	5	5	-	11.15[2]
Montague, . . .	131	80	51	-	5	23	5	1	2	1	5	2	6	4	7	11	16	18	17	13	-	19.08
Natick, ...	164	89	75	-	6	12	2	2	-	1	-	-	5	9	15	17	30	28	24	19	-	16.54
Needham, . . .	78	32	46	-	3	13	2	1	1	-	-	2	4	4	6	5	6	15	13	6	-	15.08
New Bedford, . . .	1,730	896	834	-	138	589	110	25	23	18	30	20	22	107	108	142	138	169	129	100	-	16.98
Newburyport, . . .	285	150	135	-	10	34	5	-	4	2	5	3	5	15	20	18	39	38	56	41	-	18.99
Newton, ...	462	218	244	-	33	76	12	6	4	4	3	5	9	20	21	44	35	77	79	67	-	11.43
North Adams, . .	316	182	134	-	29	59	9	5	5	-	12	2	9	22	22	26	39	48	37	21	-	14.35
Northampton,[3] . .	375	205	170	-	12	47	7	2	2	3	4	-	9	24	36	21	38	56	83	43	-	15.23[2]
North Andover, . .	54	30	24	-	4	8	-	-	-	1	2	2	1	2	5	2	13	6	8	4	-	9.45
North Attleborough, .	107	48	59	-	7	16	2	2	-	1	-	1	1	8	5	7	12	19	18	15	-	10.81
Northbridge, . . .	89	50	39	-	10	31	4	3	1	-	2	-	3	9	10	3	5	12	3	2	1	9.79
Norwood, . . .	72	36	36	-	13	8	1	1	2	1	2	-	1	5	6	6	8	10	13	8	-	8.71
Orange, ...	80	39	41	-	6	11	4	2	-	-	1	-	-	3	5	3	13	13	13	12	-	15.15
Palmer, ...	105	58	47	-	18	42	4	3	-	-	4	-	3	2	7	5	5	7	10	12	1	11.96
Peabody, ...	241	150	91	-	16	40	8	5	2	1	1	1	4	18	12	24	35	43	31	16	-	14.78
Pittsfield, . . .	560	297	263	-	28	101	15	11	6	4	8	8	13	37	47	49	54	83	74	50	-	16.58
Plymouth, . . .	250	126	124	-	10	50	12	4	3	1	4	3	4	12	23	21	20	31	35	27	-	20.23
Quincy, ...	393	212	181	-	29	87	21	6	8	1	7	2	7	27	23	32	38	48	54	30	2	11.09
Reading, ...	89	44	45	-	3	9	2	-	-	-	-	-	1	5	8	6	7	19	18	14	-	15.23

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[1] Epileptic hospital, 70 additional.

[2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being nonresidents.

[3] Nonresidents, 79, included.

TABLE II. — *Concluded.*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Revere,	186	94	92	-	18	39	6	1	1	1	3	3	3	10	5	16	28	31	20	19	-	9.49
Rockland,	96	54	42	-	6	7	1	1	1	1	1	2	1	7	5	10	10	13	23	13	-	13.61
Salem,	750	371	379	-	45	175	41	8	7	8	13	3	15	30	64	51	77	93	105	60	-	16.66
Saugus,	139	70	69	-	16	24	5	3	1	1	2	2	6	8	6	15	11	15	26	14	-	16.54
Somerville,	1,035	489	546	-	75	166	31	13	8	6	17	9	13	55	81	102	115	165	164	90	-	13.11
Southbridge,	131	58	72	1	19	38	3	5	2	1	2	2	2	4	6	9	16	16	16	9	-	10.13
South Hadley,	59	36	23	-	5	15	3	-	-	-	3	-	-	2	1	2	7	5	12	9	-	12.06
Spencer,	116	51	65	-	7	16	2	2	-	-	1	1	2	4	8	12	13	21	22	12	-	17.21
Springfield,	1,412	727	685	-	104	250	45	24	12	10	12	16	22	101	136	140	140	219	178	107	-	15.29
Stoneham,	127	65	62	-	2	10	-	-	1	-	1	2	2	10	12	9	15	23	24	18	-	17.54
Stoughton,	115	65	50	-	6	22	2	1	-	-	-	-	1	5	5	10	13	20	18	18	-	18.01
Swampscott,	78	40	38	-	5	10	2	-	2	1	1	-	1	4	3	7	4	14	18	11	-	12.16
Taunton,[1]	716	373	343	-	48	159	16	9	3	-	8	8	1	49	55	49	71	118	100	69	1	16.25[2]
Wakefield,	162	86	76	-	7	23	5	1	-	1	3	-	4	9	13	10	13	27	30	23	-	13.91
Walpole,	49	22	27	-	4	7	2	1	-	-	1	-	-	1	4	3	10	8	8	4	-	9.66
Waltham,	388	197	191	-	22	61	9	6	3	4	11	13	18	18	24	36	36	54	57	38	-	13.78
Ware,	127	69	58	-	10	24	11	1	-	1	2	1	5	5	8	12	12	16	11	18	-	14.42
Watertown,	137	76	61	-	6	34	2	-	-	1	3	5	-	5	7	11	19	20	21	8	1	10.36

Webster, ...	155	86	69	-	8	49	8	2	-	2	8	5	8	12	7	5	10	18	23	9	-	13.10
Wellesley, . . .	58	26	32	-	2	6	-	-	-	1	1	-	2	2	2	1	10	6	11	16	-	10.71
Westborough,[3] . .	194	99	95	-	2	3	-	-	1	-	1	1	2	6	21	18	35	35	46	25	-	8.97[2]
Westfield, . . .	214	112	102	-	20	48	4	7	2	2	1	3	8	12	11	18	17	27	32	22	-	12.91
West Springfield, . .	119	67	52	-	16	27	7	2	1	1	2	1	1	4	9	11	9	18	17	9	-	12.59
Weymouth, . . .	215	109	106	-	11	21	2	3	1	2	5	1	5	22	15	14	17	31	43	32	1	16.32
Whitman, . . .	86	44	42	-	7	11	1	1	-	-	2	1	-	4	2	5	9	21	20	9	-	11.55
Williamstown, . . .	53	27	26	-	3	7	1	1	1	1	-	-	3	2	5	4	6	4	10	8	-	14.29
Winchendon, . . .	101	57	44	-	6	15	1	1	-	1	4	2	3	8	2	7	7	13	15	22	-	17.79
Winchester, . . .	95	37	57	1	6	13	2	-	-	-	4	1	1	6	9	5	8	15	15	16	-	9.98
Winthrop, . . .	113	52	61	-	6	4	5	1	2	-	1	4	3	3	8	11	23	19	18	11	-	10.37
Woburn, ...	199	120	79	-	9	28	9	6	2	5	3	4	2	6	13	17	21	35	21	27	-	12.84
Worcester,[4] . . .	2,357	1,263	1,094	-	154	451	67	25	25	16	44	30	42	155	186	240	255	331	314	167	-	14.53[2]
	46,634	24,157	22,474	3	3,194	9,572	1,793	698	456	338	817	544	871	2,836	3,676	4,282	5,013	6,434	5,774	3,509	21	15.25

[1] Insane asylum, 148, included.

[2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being nonresidents.

[3] Insane hospital, 145, included.

[4] Insane hospitals, 180, included.

TABLE III.

Deaths from Specified Causes in Cities and Towns having more than 5,000 Inhabitants in Each, 1911.

	Tuberculosis, Pulmonary.	Tuberculosis other than Pulmonary.	Asiatic Cholera.	Cerebro-spinal Meningitis.	Diphtheria and Croup.	Measles.	Scarlet Fever.	Smallpox.	Typhoid Fever.	Whooping Cough.	Anterior Poliomyelitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Dysentery.	Cholera Infantum.	Other Diarrhœal Diseases.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Abington,	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	8	3	13	14	10	5	–	10	–	28
Adams,	8	3	–	1	3	–	–	–	2	4	–	1	–	–	–	1	9	–	12	6	20	–	6	14	–	6	–	93
Amesbury,	10	2	–	–	2	–	–	–	1	–	–	–	–	1	–	1	6	10	19	–	24	28	9	14	–	4	–	23
Amherst,	3	–	–	2	1	–	–	–	–	–	–	–	–	–	–	–	1	2	5	–	18	11	11	7	–	1	–	15
Andover,	8	1	–	–	–	–	1	–	2	–	–	–	–	2	–	–	1	–	10	1	18	7	1	4	2	8	2	51
Arlington,	18	1	–	2	1	–	1	–	–	–	–	–	–	3	–	1	1	1	21	7	23	5	15	11	1	11	–	62
Athol,	10	–	–	–	4	–	–	–	–	3	1	1	–	–	–	1	2	5	12	–	19	18	18	5	1	3	–	19
Attleborough,	12	8	–	–	–	1	1	–	2	1	–	–	–	3	–	–	–	10	11	4	15	20	8	6	–	14	–	68
Belmont,	3	2	–	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	13	2	20	21	8	3	1	5	4	12
Beverly,	24	–	–	–	–	–	3	–	7	1	–	–	–	–	–	–	3	2	28	4	53	21	15	25	3	15	6	75
Blackstone,	8	1	–	–	5	–	–	–	–	–	–	–	–	–	–	1	3	–	7	1	13	15	11	5	–	4	–	19
Boston,	1.037	216	1	33	124	74	74	1	63	108	4	56	41	46	4	20	696	92	1,334	148	1,377	833	830	769	125	825	68	2,721
Braintree,	1	4	–	1	–	–	2	–	–	–	–	–	–	3	–	–	1	1	10	2	18	13	5	6	4	9	–	32
Bridgewater,	4	4	–	1	–	–	–	–	–	–	–	–	–	–	–	2	–	–	3	2	9	2	2	2	1	–	–	58
Brockton,	53	8	–	1	5	1	3	–	1	3	–	2	8	4	–	5	11	19	63	12	133	52	33	44	8	20	5	174
Brookline,	10	3	–	–	2	–	1	–	2	1	–	1	–	–	–	1	1	2	30	5	72	32	25	42	1	9	–	105
Cambridge,	153	31	–	4	44	13	6	–	5	25	3	4	7	6	1	1	103	15	192	36	204	121	90	96	6	45	–	487
Chelmsford,	3	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	5	–	8	–	–	–	–	4	–	63

Chelsea, ...	37	11	-	4	4	1	5	-	4	2	-	6	2	1	-	4	10	18	66	9	94	82	38	40	5	26	17	137
Chicopee, . . .	24	3	-	2	5	-	1	-	1	2	-	-	2	-	-	-	20	41	51	9	32	22	25	16	-	14	2	117
Clinton, ...	16	1	-	1	2	-	-	-	1	-	-	1	-	1	-	1	1	1	19	3	17	20	8	16	2	13	1	57
Concord, . . .	2	2	-	-	-	-	-	-	-	-	-	1	-	2	-	-	-	-	9	1	5	5	1	4	5	1	-	23
Danvers, . . .	6	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	14	2	27	11	7	12	1	6	-	19
Dedham, . . .	6	4	-	1	-	-	-	-	-	-	-	1	-	-	-	3	-	1	17	4	26	13	5	5	1	4	-	13
Easthampton, . .	5	7	-	-	4	-	-	-	1	3	1	-	-	1	-	-	3	1	7	3	18	2	9	3	1	5	-	65
Easton, ...	4	1	-	-	1	-	1	-	-	-	-	-	-	-	-	-	1	-	9	-	14	5	2	9	-	1	-	30
Everett, ...	32	3	-	4	6	2	-	-	2	3	-	1	-	1	-	1	2	10	32	9	68	1	20	32	1	9	-	138
Fairhaven, . . .	5	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	3	10	2	17	4	5	4	1	5	3	20
Fall River, . . .	173	-	-	1	27	25	2	-	19	23	4	6	1	1	-	2	111	12	262	70	191	191	137	78	15	62	14	705
Fitchburg, . . .	31	2	-	3	15	-	1	-	3	10	-	-	-	1	-	-	6	3	61	8	66	5	17	28	5	24	9	199
Framingham, . .	10	-	-	2	1	1	-	-	5	-	-	-	-	-	1	-	-	-	23	4	14	9	7	14	2	13	-	76
Franklin, . . .	5	-	-	2	1	-	-	-	-	1	-	-	-	-	-	1	-	-	11	2	6	16	6	5	-	3	3	12
Gardner, . . .	19	-	-	1	2	-	-	-	1	2	-	-	-	-	-	-	4	3	16	6	28	14	14	9	1	5	-	63
Gloucester, . . .	30	7	-	1	-	4	1	-	1	3	-	2	1	-	-	3	5	5	33	8	21	15	16	12	3	9	-	167
Grafton, ...	6	-	-	2	-	-	-	-	1	-	-	-	-	1	-	-	5	1	14	5	9	3	1	9	3	4	-	56
Great Barrington, . .	9	1	-	-	1	1	-	-	-	-	-	1	-	2	-	-	5	-	8	3	11	10	3	2	1	1	-	23
Greenfield, . . .	7	3	-	1	1	3	-	-	1	-	-	-	-	-	-	4	9	4	15	2	22	7	3	8	-	9	1	55
Haverhill, . . .	44	13	-	1	5	-	10	-	2	2	-	3	-	3	-	-	16	2	87	6	85	65	38	46	8	26	1	170
Hingham, . . .	2	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	1	9	1	11	2	-	10	-	2	-	42
Holyoke, . . .	62	16	-	-	11	2	2	-	1	4	-	1	5	1	-	-	108	-	81	8	80	90	65	37	4	44	-	279
Hudson, ...	3	1	-	-	-	-	-	-	-	1	-	2	-	1	-	1	2	-	7	1	16	15	6	5	-	-	4	18
Hyde Park, . . .	7	6	-	-	2	-	-	-	2	-	-	3	-	-	-	1	-	2	19	2	19	6	6	16	2	12	4	102
Ipswich, ...	9	11	-	1	1	-	-	-	1	-	-	-	-	-	-	-	2	2	7	2	8	17	4	10	1	4	-	21

TABLE III. — *Continued.*

	Tuberculosis, Pulmonary.	Tuberculosis other than Pulmonary.	Asiatic Cholera.	Cerebro-spinal Meningitis.	Diphtheria and Croup.	Measles.	Scarlet Fever.	Smallpox.	Typhoid Fever.	Whooping Cough.	Anterior Poliomyelitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Dysentery.	Cholera Infantum.	Other Diarrhoeal Diseases.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Lawrence, ...	120	27	-	2	16	21	2	-	10	14	1	3	13	6	-	1	87	82	203	26	90	98	55	52	11	50	132	268
Leominster, . . .	13	1	-	1	-	-	-	-	2	-	-	-	2	-	-	-	2	10	27	6	30	8	37	11	-	17	1	118
Lexington, . . .	2	1	-	1	-	-	1	-	-	2	-	-	-	-	-	-	-	1	6	-	8	4	-	3	-	3	2	27
Lowell, ...	114	45	-	9	15	8	5	-	7	11	2	6	7	3	-	5	72	159	179	61	230	183	97	74	22	77	8	526
Ludlow, ...	1	1	-	4	3	-	-	-	1	-	-	-	1	-	-	-	10	-	8	6	2	3	1	1	1	1	-	17
Lynn, ...	85	14	-	3	12	-	1	-	8	9	-	3	6	4	1	1	15	6	122	19	122	119	65	71	6	33	8	413
Malden, ...	36	2	-	7	8	-	5	-	5	-	1	2	-	1	-	-	4	3	53	6	104	46	68	48	5	15	-	133
Mansfield, . . .	8	3	-	-	1	1	-	-	-	-	-	-	-	1	-	-	-	1	7	1	16	5	2	8	1	4	-	17
Marblehead, . . .	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	2	-	10	2	22	-	6	2	1	2	-	58
Marlborough, . . .	21	2	-	2	3	-	-	-	1	-	-	2	-	2	-	1	4	-	21	3	31	38	10	16	-	5	-	61
Maynard, . . .	8	2	-	2	2	-	-	-	1	-	-	-	-	-	-	2	8	1	12	1	6	3	-	1	-	4	1	34
Medford, . . .	23	-	-	-	6	1	-	-	-	-	1	-	-	-	-	1	1	1	31	3	39	-	17	25	-	5	-	123
Melrose, ...	10	-	-	-	-	1	1	-	-	-	-	-	1	-	-	-	2	12	7	5	27	35	14	12	2	6	3	39
Methuen, . . .	10	6	-	1	1	-	1	-	-	-	-	-	-	-	-	-	8	-	17	4	14	6	7	5	-	4	-	55
Middleborough, . .	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	5	6	26	9	-	2	4	5	-	40
Milford, ...	17	3	-	-	2	-	-	-	2	4	-	1	2	4	-	4	1	-	35	4	21	3	25	14	1	13	-	55
Milton, ...	6	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	8	-	10	6	4	-	2	2	-	58
Monson, . . .	5	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	3	4	2	9	1	3	5	-	3	9	8
Montague, . . .	3	-	-	4	5	-	2	-	-	-	-	-	-	-	-	-	6	-	22	2	20	8	1	9	-	8	9	32

Natick, ...	4	5	-	-	-	-	-	-	3	-	1	-	-	-	-	2	2	1	22	1	42	31	12	12	2	8	-	14
Needham, . . .	7	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	3	13	9	1	4	-	2	-	25
New Bedford, . .	129	29	-	7	9	3	-	-	22	13	1	5	3	2	-	-	98	140	221	50	149	88	65	55	13	20	89	519
Newburyport, . .	13	3	-	2	2	-	1	-	5	1	-	-	-	-	-	1	2	5	30	2	6	-	8	19	-	4	-	181
Newton, ...	16	9	-	1	2	4	-	-	1	-	-	1	-	4	-	1	1	17	29	6	53	42	21	28	7	28	21	170
North Adams, . .	19	4	-	2	6	-	1	-	4	2	3	1	-	-	-	-	5	9	33	6	23	5	14	20	1	16	-	140
Northampton, . .	25	5	-	3	7	-	1	-	3	1	1	-	-	2	-	2	5	11	25	4	43	50	29	15	4	17	13	108
North Andover, . .	2	1	-	2	-	-	-	-	1	-	-	-	-	-	-	-	3	-	7	-	6	2	5	6	-	1	-	19
North Attleborough, .	11	-	-	-	1	-	-	-	-	1	-	1	1	-	-	3	6	-	11	5	13	17	10	10	1	2	7	7
Northbridge, . . .	10	4	-	1	2	-	-	-	-	1	-	-	-	-	-	-	3	3	9	-	4	2	8	3	3	5	-	30
Norwood, . . .	4	5	-	-	-	-	-	-	1	1	1	1	-	1	-	1	2	-	5	3	19	6	6	7	1	4	-	4
Orange, ...	5	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	1	-	7	1	13	15	5	2	-	2	-	26
Palmer, ...	5	3	-	-	4	1	-	-	-	-	-	-	-	-	-	3	9	7	6	1	8	9	7	5	-	7	4	25
Peabody, . . .	17	-	-	-	1	-	-	-	-	4	1	5	8	2	-	6	-	2	22	4	44	17	16	8	-	18	-	66
Pittsfield, . . .	34	5	-	20	5	4	-	-	5	2	3	2	-	-	-	-	12	22	53	4	98	51	37	-	3	34	90	74
Plymouth, . . .	18	7	-	4	1	-	-	-	2	6	-	-	1	1	-	3	5	4	22	-	50	17	19	17	4	14	-	53
Quincy, ...	32	6	-	2	6	1	7	1	3	3	-	2	-	2	-	5	8	16	34	5	65	32	18	22	3	20	1	95
Reading, . . .	8	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	8	-	-	7	-	1	-	53
Revere, ...	15	4	-	1	1	-	1	-	-	1	1	-	-	1	-	3	4	1	16	11	15	18	10	17	2	5	24	35
Rockland, . . .	9	4	-	-	1	1	-	-	1	-	-	1	-	-	-	-	2	-	10	-	9	-	7	10	2	5	-	33
Salem, ...	49	11	-	3	12	2	2	-	2	10	-	-	-	-	-	5	16	36	75	17	110	60	53	42	3	19	-	224
Saugus, ...	7	2	-	4	1	-	-	-	-	5	-	-	2	-	-	3	1	4	18	2	22	16	15	11	1	7	-	17
Somerville, . . .	77	22	-	1	15	1	4	1	6	6	-	6	-	-	-	-	7	4	121	22	127	38	-	65	2	30	-	478
Southbridge, . . .	4	-	-	2	2	-	-	-	1	2	-	1	-	-	-	-	10	4	10	-	17	9	3	8	1	9	23	24
South Hadley, . .	4	-	-	1	-	-	-	-	1	1	-	-	-	1	-	-	2	-	11	1	8	4	5	-	-	2	-	18

TABLE III. — *Concluded.*

	Tuberculosis, Pulmonary.	Tuberculosis other than Pulmonary.	Asiatic Cholera.	Cerebro-spinal Meningitis.	Diphtheria and Croup.	Measles.	Scarlet Fever.	Smallpox.	Typhoid Fever.	Whooping Cough.	Anterior Poliomyelitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Dysentery.	Cholera Infantum.	Other Diarrhœal Diseases.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Spencer, ...	10	3	–	1	–	–	–	–	1	2	–	–	–	–	–	1	–	1	16	2	15	30	9	8	–	4	9	4
Springfield, . . .	77	24	–	1	9	10	2	–	18	13	1	5	12	9	1	1	78	8	147	11	149	40	161	84	14	45	5	482
Stoneham, . . .	11	4	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	9	3	26	16	5	20	1	5	–	25
Stoughton, . . .	4	3	–	–	1	–	–	–	1	–	–	2	–	4	–	–	2	–	8	2	19	8	10	3	–	3	16	29
Swampscott, . .	3	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	4	19	1	3	2	1	3	–	33
Taunton, . . .	53	6	–	1	5	–	–	–	5	8	–	4	2	5	–	4	22	60	50	15	60	55	27	24	8	13	2	285
Wakefield, . . .	15	4	–	–	1	–	–	–	2	1	–	–	1	–	–	–	–	6	19	7	28	34	9	5	–	10	–	20
Walpole, ...	2	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	9	–	5	6	1	5	–	2	–	16
Waltham, . . .	19	18	–	–	1	4	–	–	2	–	–	2	–	3	–	–	7	9	41	4	49	18	13	22	3	20	17	135
Ware, . . .	6	–	–	2	3	–	–	–	–	–	–	–	–	–	1	–	–	9	10	8	19	21	6	3	–	6	–	83
Watertown, . . .	6	–	–	–	–	–	–	–	2	–	–	1	–	–	–	1	3	–	16	–	16	5	6	11	–	2	1	66
Webster, ...	11	8	–	1	3	–	–	–	–	–	–	–	–	4	–	–	–	15	15	1	8	20	12	4	1	2	–	50
Wellesley, . . .	1	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	7	–	9	11	6	3	–	4	–	15
Westborough, . .	10	1	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	32	1	25	84	8	14	–	5	2	10
Westfield, . . .	15	–	–	–	3	–	1	–	1	–	3	–	–	1	–	–	–	–	26	3	33	13	25	8	1	7	–	74
West Springfield, . .	3	4	–	2	–	–	–	–	–	2	–	–	–	–	–	–	7	–	13	5	12	16	22	5	1	4	–	23
Weymouth, . . .	22	4	–	6	3	–	–	–	1	–	–	–	2	–	–	2	4	5	19	3	40	19	14	15	1	12	36	6
Whitman, . . .	5	1	–	1	1	–	1	–	–	1	–	1	2	–	–	1	1	–	9	1	21	10	7	10	1	–	–	12
Williamstown, . .	9	2	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	8	–	9	6	1	–	–	2	–	20

Winchendon,	4	5	-	2	-	-	-	-	1	1	-	-	-	-	-	-	-	1	16	-	16	13	6	6	-	1	-	
Winchester,	7	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	3	17	3	11	8	5	8	2	4	-	
Winthrop,	2	3	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	1	14	-	17	13	7	9	1	4	4	33
Woburn,	12	1	-	1	3	-	1	-	1	-	2	-	-	1	-	1	2	6	24	3	26	7	13	13	1	5	1	73
Worcester,	153	49	-	16	37	6	12	-	10	9	-	8	8	13	-	-	158	31	236	42	314	204	109	116	17	84	-	720
	3,399	762	1	202	508	197	167	3	276	341	36	161	143	166	10	122	1,862	991	5,028	826	5,670	3,614	2,811	2,638	377	2,079	682	13,450

	Homicide.
Adams,	1
Arlington,	1
Boston,	30
Brockton,	2
Cambridge,	2
Chicopee,	1
Clinton,	1
Easthampton,	1
Fall River,	1
Fitchburg,	1
Haverhill,	1
Holyoke,	1
Hyde Park,	1
Lawrence,	1
Malden,	2
Milford,	2
Natick,	2
North Adams,	2
Northbridge,	1
Palmer,	1
Pittsfield,	2
Quincy,	3
Saugus,	1
Somerville,	2
Southbridge,	1
Springfield,	4
Taunton,	1
Waltham,	1
Watertown,	1
Weymouth,	1
Winthrop,	2
Woburn,	2
Worcester,	3
	79

	Tetanus.
Attleborough,	2
Beverly,	1
Boston,	9
Cambridge,	3
Chelsea,	1
Fall River,	2
Leominster,	1
Marblehead,	1
Quincy,	1
Rockland,	1
Springfield,	1
Taunton,	1
Worcester,	2
	26

	Malignant pustule.
Lynn,	1

	Addison's disease.
Gloucester,	1

	Pellagra.
Northampton,	1

	Cretinism.
Northampton,	1

	Ptomaine poisoning.
Plymouth,	1

	Rodent ulcer.
Plymouth,	1

	Lymphatic Leukemia.
Walpole,	1

TABLE IV.

Deaths from Specified Causes, 1911, in Cities and Towns required to report to the State Board of Health, Death-rates per 10,000 (1907–11), Deaths per 1,000 from All Causes, 1907–11.

CAUSES OF DEATH.	Deaths 1911.	MORTALITY PER 10,000 OF THE POPULATION.					DEATHS PER 1,000 FROM ALL CAUSES.				
		1911.	1910.	1909.	1908.	1907.	1911.	1910.	1909.	1908.	1907.
Tuberculosis, pulmonary.	3,399	11.11	12.60	13.38	13.49	15.50	72.89	78.52	84.07	82.20	88.75
Tuberculosis other than pulmonary.	762	2.49	-	-	-	-	16.34	-	-	-	-
Asiatic cholera, . .	1	0.0033	-	-	-	-	0.021	-	-	-	-
Cerebro-spinal meningitis.	202	0.66	0.71	0.82	0.93	1.96	4.32	4.45	5.12	5.68	11.36
Diphtheria and croup,	508	1.66	2.16	2.37	2.45	2.61	10.89	13.46	14.89	14.95	14.90
Measles, . . .	197	0.64	0.86	0.66	1.22	0.55	4.22	5.33	4.14	7.43	3.13
Scarlet fever, . .	167	0.55	0.82	0.88	1.15	1.00	3.58	5.14	5.55	7.02	5.72
Smallpox, . . .	3	0.01	-	0.0036	0.02	0.01	0.064	-	0.022	0.12	0.09
Typhoid fever, . .	276	0.85	1.26	1.35	1.76	1.25	5.92	7.84	8.49	10.76	7.14
Whooping cough, .	341	1.12	0.76	0.92	1.01	0.81	7.31	4.74	5.76	6.13	4.65
Anterior poliomyelitis,	36	0.12	-	-	-	-	0.77	-	-	-	-
Erysipelas, . . .	161	0.53	0.59	0.55	0.40	0.49	3.45	3.66	3.48	2.45	2.81
Puerperal fever, . .	143	0.47	0.36	0.37	0.33	0.39	3.06	2.24	2.34	2.02	2.23
Influenza, . . .	166	0.54	0.81	0.80	1.04	1.56	3.56	5.08	5.03	6.83	8.91
Malarial fever, . .	10	0.03	0.02	0.05	0.03	0.08	0.21	0.15	0.32	0.16	0.47
Dysentery, . . .	122	0.40	0.58	0.60	0.53	0.53	2.02	3.59	3.78	3.21	3.04
Cholera infantum, .	1,862	6.09	7.26	7.19	7.08	5.71	39.93	45.27	45.14	43.18	32.67
Other diarrhoeal diseases.	991	3.24	-	-	-	-	21.25	-	-	-	-
Pneumonia, . .	5,028	16.44	19.32	16.82	16.88	17.98	107.80	120.42	105.67	102.94	102.98
Bronchitis, . . .	826	2.70	3.50	3.46	3.63	4.31	17.72	21.80	21.74	22.16	24.68
Diseases of the heart, .	5,670	18.54	19.07	17.33	17.36	18.43	121.60	118.85	108.88	105.84	105.52
Diseases of the brain and spinal cord.	3,614	11.82	13.68	13.50	14.03	14.10	77.50	85.28	84.79	85.57	80.72
Diseases of the kidneys,	2,811	9.19	9.31	8.96	8.46	9.15	60.28	58.04	56.27	51.58	52.38
Cancer, . . .	2,638	8.63	8.53	8.33	8.47	8.37	56.57	53.17	52.33	51.64	47.93
Suicide, . . .	377	1.23	1.20	1.25	1.36	1.35	8.11	7.46	7.85	8.29	7.74
Accident, . . .	2,079	6.80	6.15	6.03	6.37	7.19	44.58	38.35	37.86	38.82	41.16
Unknown or ill-defined causes.	682	2.23	2.48	1.51	2.79	2.15	14.63	15.49	9.47	17.02	12.30
All causes, . .	46,634	152.47	160.43	159.17	164.00	174.65	-	-	-	-	-

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Public Document **No. 56**

EIGHTEENTH ANNUAL REPORT

OF THE

BOARD OF REGISTRATION IN MEDICINE.

FOR THE YEAR ENDING DEC. 31, 1911.

BOSTON:
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1912.

APPROVED BY
THE STATE BOARD OF PUBLICATION.

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NAMES OF BOARD AND OFFICERS.

ERNST O. ENGSTROM, *President.*
PETER J. McCORMICK, *Secretary.*
IRVING P. GAMMON.
WILLIAM S. FLINT.
ALBERT J. BRUNELLE.

JOSEPH E. BUSWELL, *Agent.*

The Commonwealth of Massachusetts.

REPORT.

To His Excellency EUGENE N. FOSS, *Governor*.

SIR: — In compliance with the laws of the Commonwealth, the Board of Registration in Pharmacy has the honor to submit the following report.

The condition of the trade shows a fair yearly average with the exception of the cities where the syndicates have established drug stores. The druggists in such places complain of hard, unfair methods of doing business.

The American Pharmaceutical Association and the National Association of Boards of Pharmacy held their annual meeting in Boston in August of this year. The meetings were largely attended, and the delegates from the other States of the Union complimented the Massachusetts pharmacists, who contributed to their comfort and entertainment during their stay in our Commonwealth.

At the meeting of the National Association of Boards of Pharmacy, Ernst O. Engstrom presided, and the boards of pharmacy from the several States sent delegates to discuss betterment of Board of Pharmacy work. All our members attended the sessions, and we hope that one or more members of our Board will be delegates next year to attend the meeting of this association in Denver. This association is of great help to members of boards of pharmacy, as the proceedings printed each year will demonstrate.

There are, as near as can be ascertained by present methods, 1,710 drug stores in the State. There are also several stores which are not drug stores in the State handling drugs and medicines at retail. The Board believes it advisable to keep a record and have proper supervision over such stores, also that certain regulations should be enacted similar to those adopted in other States compelling licensing by the Board of Pharmacy each year of all stores handling drugs, medicines and poisons.

During the year a drug clerk applying for civil service examination was disqualified on account of section 16, chapter 19 of the Revised Laws, which reads as follows: —

> . . . no vendor of intoxicating liquors, shall be appointed to or retained in any office, appointment or employment to which the provisions of this chapter apply.

It seems decidedly unfair that clerks and proprietors of drug stores, who sell intoxicating liquors for medicinal, chemical and mechanical use only, should be considered vendors of intoxicating liquors within the meaning of this act.

The law proposed by the Board last year for the protection of the public, to have a registered person in charge of each drug store at all times, has had a wholesome effect. Our agent reports that conditions have materially improved.

During the year 587 candidates, the largest number in the history of the Board, have presented themselves for examination. One hundred and sixteen of them have received certificates as registered pharmacists, and 179 have received certificates as assistants.

Referring to the financial statement of the Board, it is a great pleasure to note that this commission, since the year ending 1909, has been more than self-sustaining, each year showing a larger balance. The fees transmitted to the State Treasurer this year have exceeded all expenses of the Board by $2,124.58.

The Board submits the following recommendations: —

1. Every proprietor, owner, or acting agent of a store wherein drugs, medicines or poisons are sold shall each year make an application to the Board of Pharmacy for a permit to conduct such a store, the fee for such a permit not to exceed one dollar, and the application to contain such information as will enable the Board to judiciously grant such permit.

2. That a list of stores so licensed be printed in the yearly report of the Board.

3. That section 16, chapter 19, be so amended that the words "vendor of intoxicating liquors" shall not apply to clerks or proprietors of drug stores.

Respectfully submitted,

ERNST O. ENGSTROM.
PETER J. McCORMICK.
IRVING P. GAMMON.
WILLIAM S. FLINT.
ALBERT J. BRUNELLE.

On December 1 Mr. Ernst O. Engstrom retires from the Board of Pharmacy where for five years he has labored successfully, in every way meeting the requirements of the position and always conscientiously working for the best interests of the profession of pharmacy. Mr. Engstrom has served as president of the Board for three successive years, and has also held the office of president of the National Association of Boards of Pharmacy. The valuable assistance he has rendered in improving the methods of examination is widely recognized. In the deliberations of the Board he has used sound judgment and given justice to all. We deeply regret to lose so valuable a member, and extend to him our best wishes for his future.

Respectfully submitted,

IRVING P. GAMMON.
PETER J. McCORMICK.
WILLIAM S. FLINT.
ALBERT J. BRUNELLE.

SECRETARY'S REPORT.

Meetings for examinations have been held on dates and with results as follows: —

EXAMINATIONS.

	Days.	Number examined for full Registration.	Number examined for only Assistant Registration.	Total Number examined.	Number granted Full Registration who had received Assistant Certificates prior to this Fiscal Year.	Number granted Full Registration who had received Assistant Certificates during this Fiscal Year.	Number, not Assistants, granted Full Registration.	Total Number granted Full Registration.	Number granted Assistant Certificates.	Number granted Assistant Certificates at prior Examinations, failing to receive Full Registration.	Number found not Qualified to receive any Certificate.	Total Number rejected.
December 13, .	1	14	1	15	2	–	1	3	7	4	1	5
January 3, . .	1	12	–	12	6	–	–	6	1	4	1	5
January 10, .	1	17	–	17	3	–	2	5	4	7	1	8
January 17, . .	1	16	1	17	1	–	–	1	3	10	3	13
February 7, .	1	15	1	16	–	–	1	1	6	8	1	9
February 21, .	1	18	–	18	8	–	–	8	3	7	–	7
March 7, . .	1	18	–	18	6	-	4	10	4	3	1	4
March 14, . .	1	15	1	16	–	–	1	1	4	9	2	11
March 21, . .	1	17	–	17	1	–	–	1	7	9	–	9
April 4, . .	1	18	–	18	3	1	1	5	5	8	–	8
April 10, . .	1	18	–	18	1	–	1	2	5	5	6	11
April 11, . .	1	13	5	18	2	–	–	2	4	6	6	12
April 17, . .	1	17	–	17	3	–	2	5	6	5	1	6
April 18, . .	1	15	1	16	1	–	–	1	5	1	9	10
May 2, . .	1	16	3	19	1	1	4	6	10	2	1	3
May 9, . .	1	17	–	17	2	1	2	5	7	4	1	5
May 22, . .	1	18	1	19	1	1	1	3	8	3	5	8
May 23, . .	1	16	2	18	1	–	4	5	7	4	2	6
May 29, . .	1	11	–	11	1	–	1	2	6	3	–	3
June 5, . .	1	15	–	15	1	–	–	1	4	4	6	10
June 6, . .	1	12	1	13	–	1	–	1	9	3	–	3
June 12, . .	1	14	–	14	2	–	1	3	6	2	3	5
June 13, . .	1	16	2	18	–	–	–	–	4	13	1	14
June 19, . .	1	17	2	19	3	–	1	4	2	5	8	13
June 20, . .	1	16	2	18	–	–	1	1	6	7	4	11
June 26, . .	1	19	3	22	1	1	2	4	4	11	3	14
September 12, .	1	12	3	15	1	–	–	1	7	4	3	7
September 13, .	1	12	3	15	–	–	1	1	7	4	3	7
September 25, .	1	16	2	18	3	1	1	5	6	3	4	7
October 3, . .	1	15	2	17	1	1	–	2	7	4	4	8
October 10, . .	1	18	1	19	2	1	2	5	4	4	6	10
October 23, . .	1	12	2	14	2	1	2	5	3	4	2	6
November 6, .	1	17	1	18	2	–	–	2	3	7	6	13
November 21, .	1	16	2	18	–	1	3	4	4	8	2	10
November 27, .	1	16	1	17	–	1	4	5	1	8	3	11
Totals, . .	35	544	43	587	61	12	43	116	179	193	99	292

Of the 116 candidates who passed the examinations and were registered as pharmacists: —

28 passed on first examination.
28 passed on second examination.
20 passed on third examination.
20 passed on fourth examination.
8 passed on fifth examination.
7 passed on sixth examination.
1 passed on seventh examination.
1 passed on eighth examination.
2 passed on ninth examination.
1 passed on twelfth examination.

Certificates of registration have been granted by reciprocity as follows: —

RECIPROCITY.

STATE.	Number registered.
Connecticut,	5
Maine,	11
Michigan,	1
New Hampshire,	7
North Dakota,	1
Vermont,	4
	29

FEES.

Registration fees received: —			
238 for first examination at $5,	$1,190 00		
343 for re-examination at $3,	1,029 00		
29 for reciprocity at $10,	290 00		
11 for duplicate certificates at $1,	11 00		
16 for clerical services relating to reciprocity at $1,	16 00		
Total registration fees received,		$2,536 00	
1,588 fees received for liquor certificates at $5,		7,940 00	
Interest on bank deposits,		5 70	
Total receipts,			$10,481 70
Amount paid State Treasurer,		$10,180 70	
Returned to rejected applicants for liquor certificates,		295 00	
Returned to applicants for examination upon withdrawal of their applications,		6 00	
Total credits,			$10,481 70

Of the 1,588 applications for liquor certificates received: —

Granted certificates for sixth-class licenses,	1,104
Granted certificates of fitness to sell intoxicating liquor on physicians' prescriptions only,	412
Refused,	59
Pending,	13

Expenditures.

Members' salaries: —		
Ernst O. Engstrom, president,	$600 00	
Peter J. McCormick, secretary,	1,000 00	
Irving P. Gammon,	500 00	
William S. Flint,	500 00	
Albert J. Brunelle,	500 00	
		$3,100 00
Members' expenses: —		
Ernst O. Engstrom,	$450 60	
Peter J. McCormick,	119 60	
Irving P. Gammon,	92 80	
William S. Flint,	202 00	
Albert J. Brunelle,	192 00	
		1,057 00
Joseph E. Buswell, agent: —		
Salary,	$1,500 00	
Expenses,	680 35	
		2,180 35
Stenographer, witness fees, incidental and contingent expenses: —		
Bessie B. Burroughs,	$1,000 00	
New England Telephone and Telegraph Company,	5 23	
Wright & Potter Printing Company,	350 13	
Luce's Press Clipping Bureau,	12 65	
Gilman Brothers, wholesale druggists,	27 80	
F. W. Martin Company, engrossers,	55 70	
J. L. Hammett Company,	9 96	
J. L. Fairbanks & Co.,	23 23	
Remington Typewriter Company,	1 63	
New England Railway Publishing Company,	50	
Amounts carried forward,	$1,486 83	$6,337 35

Amounts brought forward,	$1,486 83	$6,337 35
National Association of Boards of Pharmacy,	13 00	
New England Association of Boards of Pharmacy,	2 00	
O. S. Currier & Son, Haverhill,	3 43	
Neostyle Company,	4 35	
Whitall Tatum Company,	7 33	
Smith T. Downing Mfg. Company,	3 50	
Eastern Drug Company,	32 32	
The Office Appliance Company,	1 00	
H. W. Dubois & Co.,	3 00	
E. W. Burroughs, clerical services,	28 00	
A. E. Burroughs, clerical services,	4 00	
Mary Casey, services in laboratory,	34 40	
Mary Warren, services in laboratory,	1 00	
Postage,	32 00	
Witness fees,	35 50	
Laundry for laboratory,	8 05	
		1,699 71
		$8,037 06

DECEASED PHARMACISTS.

George P. Bailey, Natick.
Julian W. Baird, dean Massachusetts College of Pharmacy.
William W. Bartlett, Boston.
George H. Blatchford, Cambridge.
Benjamin F. Bradbury, Boston.
Joseph H. Buron, Fall River.
Max Cramer, Boston.
Job B. M. Dickins, Newburyport.
Seth A. Emery, Northborough.
William H. Fairfield, Boston.
Herman E. Heebner, Lee.
William T. Hunter, Everett (registered assistant).
John E. King, Boston.
Joshua A. Loomis, Easthampton.
Charles R. Lowell, Greenfield.
James J. Marrin, Holyoke.
John A. McLellan, Peabody.
William B. Milliken, Cambridge.
Charles W. Perry, Natick.
George L. Peirce, Boston.
Augustus E. Price, Gloucester.
Herbert E. Pottle, Andover.
Gualbert Roy, Fall River.
George C. Shepard, Southbridge.
Eben R. Smith, Fitchburg.
Albert H. Sweet, Milford.
John L. Thompson, Cambridge.
Harry L. Timmons, Lowell.
Frank H. Willard, Fairhaven.

SUMMARY.

Meetings: —	
For examinations,	35
For hearings, business, etc.,	13
Total number of meetings,	48

Hearings: —

On formal complaint, charge of violation of the liquor law,	18
On formal complaint, charge of aiding and abetting unregistered persons in the conduct of the drug business,	3
On formal complaint, charge of gross and confirmed habits of intoxication,	1
On formal complaint charge of violation of the narcotic law,	2
On suspension or revocation of sixth-class licenses,	8
On suspension or revocation of certificates of fitness,	8
On petitions for reinstatement,	3
In reference to applications for liquor certificates,	122
Total number of hearings,	165

Results of hearings: —

Number of certificates of registration suspended for two years,	3
Number of certificates of registration suspended for one year,	5
Number of certificates of registration suspended for three months,	1
Number of certificates of registration suspended for two months,	1
Number of cases placed on file,	12
Number of sixth-class licenses suspended,	8
Number of certificates of fitness suspended,	8
Number of suspended pharmacists reinstated,	2

Respectfully submitted,

PETER J. McCORMICK,
Secretary.

LAWS

RELATING TO

THE PRACTICE OF PHARMACY

IN

MASSACHUSETTS.

1911.

LAWS RELATING TO PHARMACY.

CHAPTER 76, REVISED LAWS.

REGISTRATION OF PHARMACISTS.

Board of registration in pharmacy, appointment, etc.

SECTION 10 (as amended by section 3, chapter 261, Acts of 1909). There shall be a board of registration in pharmacy consisting of five persons, residents of the commonwealth, who shall be skilled pharmacists, and shall have had ten consecutive years of practical experience in the compounding and dispensing of physician's prescriptions, and shall be actually engaged in the drug business. Not more than one member shall have any financial interest in the sale of drugs, medicines and chemicals, and the compounding and dispensing of physician's prescriptions in the same councillor district. One member of said board shall annually in November be appointed by the governor, with the advice and consent of the council, for a term of five years from the first day of December following, and no person appointed after the twenty-fifth day of June in the year eighteen hundred and ninety-nine shall serve as a member of said board for more than five consecutive years. The members of said board at the time of the enactment hereof, and any member thereafter appointed to fill a vacancy, who are holding office at the expiration of their official terms, shall continue in office until the first day of December following.

Organization, meetings, etc.

SECTION 11 (as amended by section 4, chapter 261, Acts of 1909). Said board shall meet on the first Tuesday of December in each year at such time and place as it may determine and shall organize by electing a president and secretary, who shall be members of the board and who shall hold their offices for the term of one year. The secretary shall give to the treasurer and receiver general a bond with sufficient sureties, to be approved by the governor and council, for the faithful performance of his official duties. The board shall annually hold regular meetings on the first Tuesday of January, May and October, and additional meetings at such times and places as it shall determine.

Salaries.

SECTION 12. (Section 1, chapter 399, Acts of 1907.) The annual salary of the secretary of the board of registration in pharmacy shall be one thousand dollars, and that of the other members of the board shall be five hundred dollars each, except that the chairman shall receive six hundred dollars.

Travelling expenses, etc.

(Sections 4 and 5, chapter 505, Acts of 1902.) Each member of the board shall receive in addition to his salary his necessary travelling expenses actually incurred in attending the meetings of the board. The salaries and expenses of the members of the board shall be paid out of the treasury of the commonwealth. The fees received for examination and registration of applicants before the board of registration in pharmacy shall be paid monthly by the secretary into the treasury of the commonwealth.

Record and annual report.

SECTION 13. The board shall keep a record of the names of all persons examined and registered hereunder and of all money received and disbursed by it, and a duplicate thereof shall be open to inspection in the office of the secretary of the commonwealth. Said board shall annually, on or before the first day of January, make a report to the governor and council of the condition of pharmacy in the commonwealth, of all its official acts during the preceding year and of its receipts and disbursements.

Examination for registration as a pharmacist.

Certificates as assistants.

Registration by reciprocity.

SECTION 14 (as amended by section 3, chapter 525, Acts of 1908). A person who desires to do business as a pharmacist shall, upon payment of five dollars, be entitled to examination, and if found qualified shall be registered as a pharmacist and shall receive a certificate signed by the president and secretary of said board. Any person who fails to pass such examination shall upon request be re-examined after the expiration of three months at any regular meeting of the board, upon the payment of three dollars. The board of registration in pharmacy may grant certificates of registration as assistants after examination upon the terms above named, but such certificates shall not allow the holder thereof to carry on the business of pharmacy. The said board may, in its discretion, grant certificates of registration to such persons as shall furnish with their application satisfactory proof that they have been registered by examination in some other state: *provided,* that such other state shall require a degree of competency equal to that required of applicants in this state. Every applicant for registration as a registered pharmacist shall pay to the secretary of the board the sum of ten dollars at the time of filing the application. No certificate known as the reciprocity certificate shall be granted until the person so applying shall have signified his intention of acting under the same in this commonwealth. All fees received by the board shall be paid by its secretary into the treasury of the commonwealth.

Exhibit of certificate.

SECTION 15. Every person who has received a certificate of registration from the board shall conspicuously display the same in his place of business.

Hearings on applications and complaints.

SECTION 16 (as amended by chapter 140, Acts of 1907, as amended by section 2, chapter 172, Acts of 1910). The board shall hear all applications by registered pharmacists for the granting of sixth class licenses, if a hearing is requested by the applicant, and all complaints made to them against any person registered as a pharmacist charging him in his business as a pharmacist with violating any of the laws of the commonwealth, and especially of the laws relating to the sale of intoxicating liquors; or engaging with, or aiding or abetting, another in the violation of said laws; or, if he himself is not the owner and actively engaged in such business, with suffering or permitting the use of his name or certificate of registration by others in the conduct of the business of pharmacy. Such complaint shall set out the offence alleged and be made within fifteen days after the date of the act complained of, or within thirty days after a conviction by a court of competent jurisdiction. The board shall notify the person complained against of the charge against him and of the time and place of the hearing at which he may appear with his witnesses and be heard by counsel. Three of the members of the board shall be a quorum for such hearing. Witnesses at hearings before such board shall testify under oath and may be sworn by a member of the board. The board shall have power to send for persons and compel the attendance of witnesses at said hearings.

Board may suspend certificates of registration, etc.

SECTION 17 (as amended by chapter 321, Acts of 1902). If the full board sitting at such hearing finds the person guilty, the board may suspend the effect of the certificate of his registration as a pharmacist for such term as the board fixes, but the license or certificate of registration of a registered pharmacist shall not be suspended or revoked for a cause punishable by law until after his conviction by a court of competent jurisdiction. (Chapter 261, section 5, Acts of 1909: The board may suspend the certificate of registration of a registered pharmacist, who, in its judgment, is a menace to the public by reason of the improper use of intoxicating liquor or drugs, such suspension to be made only after a hearing, and by the unanimous vote of all the members of the board.) The board may at any time in its discretion reconsider its action in cases where it has suspended or revoked the license or certificate of registration of a pharmacist, and may change its determination as justice shall require.

Board may reconsider its action.

Penalty for sale of drugs by unregistered persons.

SECTION 18 (as amended by section 2, chapter 525, Acts of 1908). Whoever, not being registered as aforesaid, retails, compounds for sale or dispenses for medicinal purposes or keeps or exposes for sale drugs, medicines, chemicals or poisons, except as provided in section twenty-three, shall be punished by a fine of not more than fifty dollars. But the provisions of this section shall not prohibit the employment of apprentices or assistants under the personal supervision of a registered pharmacist. Every registered pharmacist engaged in the business of pharmacy shall cause his name to appear on every sign indicating or advertising his place of business and on every label used for medicinal preparations compounded in his place of business. No unregistered copartner shall hereafter be actively engaged in the business of pharmacy; but this provision shall not apply to those engaged in the business at the time of the enactment hereof.

Registered person's name on signs and labels.

Inability of unregistered copartner to be actively engaged in pharmacy.

Investigation of complaints.

SECTION 19. The board shall investigate all complaints of the violation of the provisions of sections ten to twenty-three, inclusive, and report the same to the proper prosecuting officers, and especially investigate and cause to be prosecuted all violations of sections twenty-one to twenty-nine, inclusive, of chapter one hundred.

Access to documents.

SECTION 21. A registered pharmacist against whom a complaint or charge is pending before the board, or his counsel shall have the same right of access to documents in the possession of said board as a person who is charged with crime in the courts of the commonwealth would have to documents in the possession of the clerk of the court or of the prosecuting officer.

Court to furnish certificate of conviction.

SECTION 22. The court or magistrate before whom a person is convicted of a violation of section twenty-six of chapter seventy-five, of section eighteen of this chapter, of sections twenty-five, twenty-six, twenty-seven of chapter one hundred or of section two of chapter two hundred and thirteen shall send to the board of registration in pharmacy a certificate under seal showing the time, cause and place of conviction.

As to the sale of certain drugs and medicines by grocers and others, not registered.

SECTION 23 (as amended by chapter 327, Acts of 1902, as amended by section 3, chapter 525, Acts of 1908, as amended by section 1, chapter 172, Acts of 1910). The provisions of sections twenty-one to twenty-nine, inclusive, of chapter one hundred, section twenty-six of chapter seventy-five and section two of chapter two hundred and thirteen shall not apply to physicians who put up their own prescriptions or dispense medicines to their patients; nor to the sale of drugs, medicines, chemicals or poisons at wholesale only; nor to the manufacture or sale of patent or proprietary medicines; nor to the sale by merchants at retail of the following drugs and chemicals used in the arts, or as household remedies: — alum, ammonia, bicarbonate of soda, borax, camphor, castor oil, chlorinated lime, citric acid, cod liver oil, copperas, cotton seed oil, cream of tartar, dye stuffs, Epsom salt, flaxseed, flaxseed meal, gelatin, ginger, Glauber's salt, glycerine, gum arabic, gum tragacanth, hops, hyposulphite of soda, licorice, lime water, linseed oil, litharge, magnesia, olive oil, peroxide of hydrogen, petrolatum, phosphate of soda, rhubarb, Rochelle salt, rosin, sal ammoniac, saltpeter, senna, slippery elm bark, spices of seasoning, sugar of milk, sulphate of copper, sulphur, tartaric acid, turpentine, extract of witch hazel, and zinc oxide; nor to the sale in original packages of the following, if put up by registered pharmacists, manufacturers, or wholesale dealers, in conformity with the Revised Laws, namely: — flavoring essences or extracts, essence of Jamaica ginger, insecticides, rat exterminators, aromatic spirits of ammonia, spirits of camphor, sweet spirits of nitre, syrup of rhubarb, tincture of arnica, and tincture of rhubarb; nor to the sale of the following poisons used in the arts, if properly labelled and recorded as provided in section two, chapter two hundred and thirteen of the Revised Laws: — muriatic acid, oxalic acid, nitric acid, sulphuric acid, arsenic, cyanide of potassium, mercury, phosphorus, and sulphate of zinc. Whoever not being a registered pharmacist, sells, or offers for sale, at retail, drugs, medicines, or poisons, other than those enumerated above, shall be punished by a fine not exceeding fifty dollars. The widow, executor or administrator of a registered pharmacist who has died or the wife of one who has become incapacitated may continue his business under a registered pharmacist, who may also be considered qualified to receive a sixth class license to be exercised upon said premises of said deceased or incapacitated pharmacist under the registered licensee's personal supervision. The provisions of section twenty-two of chapter one hundred, so far as they may be inconsistent herewith, shall not apply to licenses issued hereunder.

Widow, etc., may continue business, etc.

CHAPTER 100, REVISED LAWS.

SECTION 2. Ale, porter, strong beer, cider, all wines, any beverage which contains more than one per cent of alcohol, by volume, at sixty degrees Fahrenheit, and distilled spirits, shall be deemed to be intoxicating liquor within the meaning of this chapter.

Definition of intoxicating liquor.

SECTION 16. The licensing board may at any time refuse to issue a license to a person whom it considers unfit to receive the same; but the provisions of this chapter shall not be so construed as to compel said licensing board to grant licenses.

Licenses may be refused to unfit persons.

SECTION 17. Each license shall be expressed, to be subject to the following conditions: —

Conditions of licenses.

First, That the provisions in regard to the nature of the license, and the building in which the business may be carried on under it, shall be strictly adhered to.

Sales prohibited certain hours and Lord's day.

Second, That spirituous or intoxicating liquor shall not be sold between the hours of eleven at night and six in the morning or on the Lord's day; but if the licensee is also licensed as an innholder he may, between the hours of six in the morning and eleven at night on the Lord's day, supply such liquors to guests who have resorted to his inn for food and lodging.

Quality of liquor.

Third, That spirituous or intoxicating liquor shall not be sold, exchanged or delivered, or exposed, offered or kept for sale, exchange or delivery, upon the licensed premises, unless it is of good standard quality and is free from any adulteration prohibited in the Pharmacopœia of the United States or by the laws relative to adulteration of drugs and food, for either a food or a drug. If it is marked, labelled or represented as being the product of any foreign country, it shall also be of the standard quality required for its legal sale for domestic use in the country of its reputed production. All such liquors which are sold, exchanged or delivered, or which are exposed or kept for sale, exchange or delivery, under a license of the sixth class, shall be of the quality required for their sale as drugs under the provisions of the laws relative to the adulteration of drugs and food.

Sales prohibited to certain persons.

Fourth, That liquor shall not be sold or delivered on the licensed premises to a person who is known to be a drunkard, to an intoxicated person, or to a person who is known to have been intoxicated within the six months last preceding, or to a minor, either for his own use, the use of his parents or of any other person, or, unless upon the prescription of a duly registered physician, to a person known to have been supported in whole or in part by public charity at any time during the twelve months last preceding the date of the license.

Conduct on premises.

Fifth, That there shall be no disorder, indecency, prostitution, lewdness, or illegal gaming on the licensed premises, or on any premises connected therewith by an interior communication.

License displayed.

Sixth, That the license, or a copy thereof, certified by the recording officer of the licensing board, or by the clerk of the city or town by which it is issued, shall be displayed on the premises, in a conspicuous position, where it can easily be read.

License subject to forfeiture.

Seventh, That the license shall be subject to forfeiture, as herein provided, for breach of any of its conditions; and that, if the licensee is convicted of a violation of any of such conditions, his license shall thereupon become void.

SECTION 21 (as amended by chapter 190, Acts of 1907). Druggists and apothecaries having a sixth class license or a certificate of fitness, may sell pure alcohol for medicinal, mechanical or chemical purposes without a physician's prescription, the said sales to be recorded in the manner provided for in section twenty-six; and wholesale druggists and apothecaries may also sell liquor of any kind, not to be drunk on the premises, under a license of the fourth class.

Sales of alcohol.

SECTION 22. No license for the sale of spirituous or intoxicating liquor, except of the sixth class, shall be granted to retail druggists or apothecaries. One or more licenses of the sixth class shall be granted annually by the licensing board of cities, or by the mayor and aldermen of cities having no such board, or by the selectmen of towns, to retail druggists or apothecaries who are registered pharmacists actively engaged in business on their own account, upon presentation to the licensing board of the certificate of fitness prescribed by the following section, if it appears that the applicant is a proper person to receive such license, and is not disqualified to receive it under the provisions of sections fifty-three and fifty-four. A registered pharmacist who owns stock of the actual value of at least five hundred dollars in a corporation which has been incorporated for the purpose of carrying on the drug business, and who conducts in person the business of a store of such corporation, shall be considered as actively engaged in business on his own account and as qualified to receive a license for such store.

Licenses to druggists.

Registered stockholder.

SECTION 23 (as amended by chapter 308, Acts of 1907, as amended by chapter 261, Acts of 1909). The board of registration in pharmacy may, upon the payment by an applicant for a license of the sixth class of a fee of not more than five dollars, issue to him a certificate, which shall not be valid after one year from its date, stating that in the judgment of said board he is a proper person to be entrusted with such license and that the public good will be promoted by the granting thereof. The board may, after giving a hearing to the parties interested, revoke or suspend such certificate for any cause that it may deem proper, and such revocation or suspension shall revoke or suspend the sixth class license granted thereon.

Certificate of fitness for license.

SECTION 24. A license of the sixth class shall become null and void without any process or decree, if the registered pharmacist to whom it has been granted ceases to conduct his business in person and on his own account, or upon the revocation of his certificate of registration as a pharmacist, unless the registered pharmacist has become unable to so conduct his business or has died, and his business is continued by his wife,

License to be void, when.

widow, executor or administrator under another registered pharmacist.

Sale only on certificate.

SECTION 25. Retail druggists and apothecaries shall not sell intoxicating liquor of any kind for medicinal, mechanical or chemical purposes except upon the certificate of the purchaser, which shall state the use for which it is wanted, and which shall be immediately cancelled at the time of sale in such manner as to show the date of cancellation. They shall not, when making such sales upon the prescription of a physician, be subject to the provisions of the second clause of section seventeen.

Entry book for sales of liquor.

SECTION 26. Every retail druggist and apothecary shall keep a book in which he shall enter, at the time of every such sale, the date thereof, the name of the purchaser, the kind, quantity and price of said liquor, the purpose for which it was sold, and the residence by street and number, if there be such, of said purchaser. If such sale is made upon the prescription of a physician, the book shall also contain the name of the physician and shall state the use for which said liquor is prescribed and the quantity to be used for such purpose, and shall be cancelled in the manner before provided with reference to certificates. Said book shall be in form substantially as follows:—

Date.	Name of Purchaser.	Residence.	Kind and Quantity.	Purpose of Use.	Price.	Name of Physician.

The certificate mentioned in the preceding section shall be a part of said book, and shall not be detached therefrom, and shall be in form substantially as follows:—

Certificate.

I wish to purchase..
and I certify that I am not a minor and that the same is to be used for * Mechanical * Chemical * Medicinal purposes. [*Draw a line through the words which do not indicate the purpose of the purchase.]

Signature....................................

Cancelled....................................

Books open to inspection.

SECTION 27. The book, certificates and prescriptions provided for in the two preceding sections and the book provided for in section thirty-two shall at all times be open to the inspection of the licensing board in cities having such boards and in all other cities and towns, to the inspection of the mayor and aldermen, selectmen, overseers of the poor, sheriffs, constables, police officers and justices of the peace.

Penalty for false certificate. SECTION 28. Whoever makes or issues a false or fraudulent certificate or prescription referred to in sections twenty-five and twenty-six shall be punished by a fine of ten dollars.

Penalty for sale of liquor in name of pharmacist. SECTION 29. Whoever, not being a registered pharmacist, procures a sixth class license for the sale of intoxicating liquors in the name of a registered pharmacist who is dead, or in the name of a registered pharmacist by borrowing, hiring or purchasing the use of his certificate, and who, being himself the owner or manager of the place, shall himself or by his servants sell intoxicating liquor, shall be punished by a fine of not less than fifty nor more than five hundred dollars, and by imprisonment for not less than one nor more than six months. The provisions of section ten of chapter two hundred and twenty shall not apply to such sentence.

Transfer of licenses. SECTION 44. Licensing boards may transfer licenses from one location to another within the city or town in which such licenses are in force; but such transfer shall be granted only to the original licensee, and like notice shall be given, the same provisions shall apply, and other proceedings shall be the same as are required upon the granting of licenses, except that no new license fee shall be required.

Forfeiture of license. SECTION 47 (as amended by chapter 108, Acts of 1908). The licensing board, after notice to the licensee and reasonable opportunity for him to be heard by them or by a committee of the mayor and aldermen or selectmen, if the license was granted by them, may declare his license forfeited, or may suspend his license for such period of time as they may deem proper, upon satisfactory proof that he has violated or permitted a violation of any condition thereof, or any law of the commonwealth. The pendency of proceedings before a court or justice shall not suspend or interfere with the power herein given to decree a forfeiture. **Licensee disqualified.** If the license is declared to have been forfeited, the licensee shall be disqualified to receive a license for one year after the expiration of the term of the license so forfeited, and if he is the owner of the premises described in such forfeited license, no license shall be issued to be exercised on said premises for the residue of the term thereof.

Penalties. SECTION 53. Whoever violates any provision of his license or of this chapter shall, unless otherwise expressly provided, be punished by a fine of not less than fifty nor more than five hundred dollars, and by imprisonment for not less than one nor more than six months; and such conviction of a licensee shall render any license to him of the first five classes, of the seventh class, and, if for a violation of sections twenty-five to twenty-seven inclusive, a license of the sixth class, void. Such licensee shall be disqualified to hold a license for one year after his conviction, and, if he is the owner of the licensed premises, no license shall be exercised on the premises described in the forfeited license during the residue of the term thereof.

Penalty for furnishing liquor, etc., to a minor.

SECTION 62. Whoever, himself, or by his agent or servant, sells or gives intoxicating liquors to a minor, either for his own use, the use of his parent, or of any other person, or allows a minor to loiter upon the premises where such sales are made, shall forfeit one hundred dollars for each offense, to be recovered by the parent, etc. The provisions of this section shall not apply to sales made by the holder of a license of the sixth class if made upon the written prescription of a practising physician.

Penalty for selling liquor to a person contrary to notice.

SECTION 63. The husband, wife, parent, child, guardian or employer of a person who has the habit of drinking spirituous or intoxicating liquor to excess, or the mayor of the city, or one of the selectmen of the town in which such person lives, may give notice in writing, signed by him or her, to any person requesting him not to sell or deliver such liquor to the person having such habit. If the person so notified at any time within twelve months thereafter sells or delivers such liquor to the person having such habit, or permits him to loiter on his premises, the person giving the notice may, in an action of tort, recover of the person notified such amount, not less than one hundred nor more than five hundred dollars, as may be assessed as damages; etc.

CHAPTER 281, ACTS OF 1906.

AN ACT RELATIVE TO THE SALE OF INTOXICATING LIQUORS BY REGISTERED PHARMACISTS.

Be it enacted, etc., as follows:

Sale on prescription, having a certificate of fitness in no-license places.

SECTION 1. In any city or town in which licenses for the sale of intoxicating liquors of the first five classes are not granted, registered pharmacists to whom a certificate of fitness has been issued as provided for by section two of this act, may sell intoxicating liquors upon the prescription of a registered physician practising in such city or town, provided that the prescription is dated, contains the name of the person prescribed for, and is signed by the physician. All such prescriptions shall be retained and kept on file in a separate book by the pharmacist filling the same, and shall not be filled a second time. Such prescription book shall be open at all times to the inspection provided for in section twenty-seven of chapter one hundred of the Revised Laws.

Fee. SECTION 2 (as amended by chapter 261, Acts of 1909). The board of registration in pharmacy may, upon the payment by each applicant of a fee of not more than five dollars, issue to registered pharmacists certificates of fitness as provided for in section twenty-three of said chapter one hundred. **Suspension or revocation of certificate.** Such certificates of fitness shall be subject to suspension or revocation by the board of registration in pharmacy, or by the licensing authorities of such cities and towns.

Penalty. SECTION 3. Whoever violates any provision of this act shall be punished by a fine of not less than fifty nor more than five hundred dollars, or by imprisonment for not less than one month nor more than six months, or by both such fine and imprisonment.

Repeal. SECTION 4. All acts and parts of acts inconsistent herewith are hereby repealed. *Approved April 14, 1906.*

CHAPTER 213, REVISED LAWS.

OF CRIMES AGAINST THE PUBLIC HEALTH.

Sale of poisons. SECTION 2. Whoever sells arsenic (arsenious acid), atropia or any of its salts, chloral hydrate, chloroform, cotton root and its fluid extract, corrosive sublimate, cyanide of potassium, Donovan's solution, ergot and its fluid extract, Fowler's solution, laudanum, McMunn's elixir, morphia or any of its salts, oil of pennyroyal, oil of savin, oil of tansy, opium, Paris green, Parsons' vermin exterminator, phosphorus, prussic acid, "rough on rats", strychnia or any of its salts, tartar emetic, tincture of aconite, tincture of belladonna, tincture of digitalis, tincture of nux vomica, tincture of veratrum viride, or carbolic acid, without the written prescription of a physician, shall affix to the bottle, box or wrapper containing the article sold a label of red paper upon which shall be printed in large black letters the name and place of business of the vendor and the words *Poison* and *Antidote,* and the label shall also contain the name of an antidote, if any, for the poison sold. He shall also keep a record of the name and quantity of the article sold and of the name and residence of the person or persons to whom it was delivered, which shall be made before the article is delivered and shall at all times be open to inspection by the officers of the district police and by the police authorities and officers of cities and towns; but no sale of cocaine or its salts shall be made except upon the prescription of a physician. Whoever neglects to affix such label to such bottle, box or wrapper before delivery thereof to the purchaser or whoever neglects to keep or refuses to show to said officers such record or whoever purchases any of said poisons and gives a false or fictitious name to the vendor shall be punished by a fine of not more than fifty dollars. The provisions of this section shall not apply to sales by wholesale dealers or manufacturing chemists to retail dealers, or to a general merchant who sells Paris green, London purple or other arsenical poisons in unbroken packages containing not less than one-quarter of a pound, for the sole purpose of destroying potato bugs or other insects upon plants, vines or trees, except that he shall record each sale and label each package sold, as above provided.

CHAPTER 541, ACTS OF 1910.

AN ACT RELATIVE TO THE LABELLING OF CRUDE AND REFINED WOOD ALCOHOL.

Be it enacted, etc., as follows:

Crude and refined wood alcohol to be labelled.

SECTION 1. Whoever, himself, or by his servant or agent, or as the servant or agent of any other person sells, exchanges or delivers any wood alcohol, otherwise known as methyl alcohol, either crude or refined, or denatured alcohol which contains any methyl alcohol, under or by whatever name or trade mark the same may be called or known shall affix to the bottle or vessel containing the same a label bearing the words, "Poison, Not for Internal Use", in red letters of uncondensed Gothic type not less than one fourth of an inch in height, and the same words, "Poison, Not for Internal Use", in stencilled letters or similar Gothic type of a size not less than three fourths nor more than one and one half inches in height for use on barrels and kegs. Whoever violates any provision of this section shall pay a fine of not less than fifty nor more than two hundred dollars for each sale in respect to which the violation occurs.

Penalty.

Penalty for the sale, etc., of food or drink containing wood alcohol, etc.

SECTION 2. Whoever, himself, or by his servant or agent, or as the servant or agent of any other person sells, exchanges or delivers, or has in his possession with intent to sell, exchange or deliver, any article of food or drink, or any drug intended for internal use, containing any wood alcohol, otherwise known as methyl alcohol, either crude or refined, under or by whatever name or trade mark the same may be called or known, shall be punished by a fine of not less than two hundred dollars, or by imprisonment for not more than thirty days, or by both such fine and imprisonment.

Repeal. SECTION 3. Chapter two hundred and twenty of the acts of the year nineteen hundred and five, relative to wood alcohol, is hereby repealed. *Approved May 23, 1910.*

CHAPTER 259, ACTS OF 1907.

AN ACT RELATIVE TO THE LABELLING OF CERTAIN PATENT OR PROPRIETARY DRUGS AND FOODS.

Be it enacted, etc., as follows:

Receptacles holding proprietary or patent medicines, etc., to be labelled. SECTION 1. Chapter three hundred and eighty-six of the acts of the year nineteen hundred and six is hereby amended by striking out section one and inserting in place thereof the following: — *Section 1.* Upon every package, bottle or other receptacle holding any proprietary or patent medicine, or any proprietary or patent food preparation, which contains alcohol, morphine, codeine, opium, heroin, chloroform, cannabis indica, chloral hydrate, or acetanilid, or any derivative or preparation of any such substances, shall be marked or inscribed a statement on the label of the quantity or proportion of each of said substances contained therein. The size of type in which the names of the above substances shall be printed on the labels as above, shall not be smaller than eight point (brevier) caps: *provided,* that in case the size of the package will not permit the use of eight point cap type the size of the type may be reduced proportionately. The provisions of section nineteen of chapter seventy-five of the Revised Laws, so far as they are consistent herewith, shall apply to the manner and form in which such statements shall be marked or inscribed.

SECTION 2. No dealer shall be prosecuted under the provisions of this act when he can establish a guaranty signed by the wholesaler, jobber or manufacturer residing in this Commonwealth, from whom he purchased such articles, to the effect that the same is not misbranded within the meaning of this act, designating it. Such guaranty, to afford protection, shall contain the name and address of the party or parties making the sale of such articles to such dealer; and in such case said party or parties shall be amenable to the prosecutions, fines and other penalties which would attach, in due course, to the dealer under the provisions of this act.

SECTION 3. Section two of chapter three hundred and eighty-six of the acts of the year nineteen hundred and six is hereby repealed.

SECTION 4. This act shall take effect on the first day of March in the year nineteen hundred and eight.

Approved March 29, 1907.

CHAPTER 387, ACTS OF 1910.

AN ACT RELATIVE TO THE SALE OF COCAINE.

Be it enacted, etc., as follows:

Manufacture of preparations containing cocaine, etc., prohibited.

SECTION 1. It shall be unlawful for any person, firm or corporation to manufacture any so-called catarrh powder or catarrh cure, or any patent or proprietary preparation containing cocaine, or any of its salts, or alpha or beta eucaine, or any of their salts, or any synthetic substitute for them.

Sale, etc., of cocaine, etc., prohibited except, etc.

SECTION 2. It shall be unlawful for any person, firm or corporation to sell or to expose or offer for sale or to give, deliver or exchange any cocaine, or any alpha or beta eucaine, or any synthetic substitute for them, or any preparation containing the same, or any salts or compounds thereof, except upon the written prescription of a physician, dentist or veterinary surgeon registered under the laws of the state in which he resides; the original of which prescription shall be retained by the druggist filling the same for a period of at least two years and shall not again be filled, except upon the written order of the original prescriber, and shall at all times be open to inspection by the officers of the state board of health, the members of the state board of registration in pharmacy and its authorized agents, and by the police authorities and officers of cities and towns. But no practitioner of veterinary medicine shall prescribe any of the above mentioned substances for the use of any human being.

Physicians and dentists not to prescribe, etc., in certain cases.

SECTION 3. It shall be unlawful for any physician or dentist to prescribe, sell or give away any cocaine or its salts, or any alpha or beta eucaine or their salts, or any synthetic substitute for them, or any preparation containing the same, or any salts or compounds thereof, to any person known to such physician or dentist to be an habitual user of those drugs.

To whom cocaine, etc., may be sold.

SECTION 4. Any manufacturer or jobber of any or all of the articles mentioned in section two of this act, any wholesale druggist, or any registered pharmacist may sell any article mentioned in said section two to any such manufacturer, jobber, wholesale druggist, or to any pharmacist, physician, veterinarian or dentist, registered under the laws of the state in which he resides, or to any incorporated hospital, but only upon a written order duly signed by such manufacturer, jobber, wholesale druggist, registered pharmacist, registered physician, registered veterinarian, registered dentist, or the superintendent of such incorporated hospital, which order shall show the article or articles ordered and the date of delivery. The said order shall be kept on file in the laboratory, warehouse, pharmacy or store from which it was filled by the proprietor thereof, or his successor, for a period of not less than two years from the date of delivery, and shall at all times be open to inspection by the officers of the state board of health, the members of the state board of registration in pharmacy and its authorized agents, and by the police authorities and officers of cities and towns; and such order shall not contain any articles not mentioned in section two of this act.

Order to be kept on file.

SECTION 5 (as amended by chapter 341, Acts of 1911). Whoever violates any provision of the foregoing sections shall be punished by a fine of not less than fifty and not more than one thousand dollars, or by imprisonment for not more than one year in the county jail or house of correction, or by both such fine and imprisonment, and whoever is found present as described in section seven of this act shall be punished by a fine of not more than fifty dollars, or by imprisonment for three months in the house of correction.

Penalty.

. . . .

CHAPTER 271, ACTS OF 1910.

AN ACT TO REGULATE THE SALE OF MORPHINE AND OTHER NARCOTIC DRUGS.

Be it enacted, etc., as follows:

SECTION 1. It shall be unlawful for any person to sell, furnish, give away or deliver any opium, morphine, heroin, codeine or preparations thereof, or any salt or compound of the said substances, except upon the written prescription or order of a lawfully authorized practitioner of medicine, dentistry, or veterinary medicine, which prescription shall bear the name of the person giving it. But the provisions of this section shall not apply to sales made by any manufacturer, wholesale or retail druggist to another manufacturer, wholesale or retail druggist; nor to sales made to hospitals, colleges, scientific or public institutions, or to physicians, dentists, or veterinary surgeons; nor to the sale of cough remedies and other domestic and proprietary preparations: *provided,* that such preparations are sold in good faith as medicines, and not for the purpose of evading the provisions of this act; and *provided,* that such preparations do not contain more than two and one half grains of opium, or one third of a grain of morphine, or one fourth of a grain of heroin, or one grain of codeine or their salts in

Sale of certain narcotic drugs regulated.

Provisos.

one fluid ounce; or if a solid preparation, in one avoirdupois ounce, excepting liniments and ointments which are prepared for external use only; nor to preparations containing opium or any of its salts, which are sold in good faith, for diarrhœa, cholera or neuralgia; nor to powder of ipecac and opium, commonly known as Dover's powders; nor to compound medicinal tablets, pills, or powders containing not over one twentieth of a grain of morphine, or one twelfth of a grain of heroin or one fourth of a grain of codeine, or any of their salts to each pill, powder or tablet, *provided,* that such preparations are sold in good faith as medicines and not for the purpose of evading the provisions of this act.

Prescription of certain drugs regulated.

SECTION 2. It shall be unlawful for any practitioner of medicine, dentistry, or veterinary medicine to prescribe for the use of any habitual user of the same, opium, morphine, heroin, codeine, or any salt or compound of the said substances, or any preparation containing any of the said substances or their salts or compounds; nor shall any practitioner of dentistry prescribe any of the said substances for any person not under his treatment in the regular practice of his profession; nor shall any practitioner of veterinary medicines prescribe any of the said substances for the use of any human being: *provided, however,* that the provisions of this section shall not be construed to prevent any lawfully authorized practitioner of medicine from prescribing in good faith for the use of any habitual user of narcotic drugs who is under his professional care such substances as he may deem necessary for his treatment, when such prescriptions are given in good faith and not for the purpose of evading the provisions of this act.

Penalty.

SECTION 3. Whoever violates any provision of this act shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be fined not less than five dollars nor more than one thousand dollars; or shall be imprisoned in the house of correction or jail for a term not exceeding one year; or shall be punished by both such fine and imprisonment.

Approved March 22, 1910.

CHAPTER 416, ACTS OF 1910.

AN ACT RELATIVE TO PROSECUTIONS UNDER THE LAWS RELATIVE TO ADULTERATED DRUGS AND FOOD.

Be it enacted, etc., as follows:

Prosecutions under laws relative to adulterated drugs and food.

SECTION 1. No prosecution shall be begun under sections sixteen to twenty-seven, inclusive, of chapter seventy-five of the Revised Laws, for the manufacture, sale or offering for sale of drugs, unless the person purchasing the drug or taking the drug without purchasing shall seal and deliver to the owner or person from whom such drug is purchased or taken a portion of the drug so purchased or taken; and a receipt therefor shall be given to the collector. The drug so purchased or taken shall thereafter be analyzed or tested under the direction of the state board of health for the purpose of determining whether it comes within the provisions of the sections above mentioned.

Complaint for violation of law, etc.

SECTION 2. If it appears that any provision of the said sections has been violated, the said board may direct or authorize formal complaint to be made to a court or justice having jurisdiction in such cases; but no evidence of the result of said analysis or test shall be received if the collector refuses or neglects to seal and deliver a portion of the drug purchased or taken as aforesaid to the owner or person from whose possession it is taken. *Approved April 20, 1910.*

CHAPTER 289, ACTS OF 1911.

AN ACT RELATIVE TO PROSECUTIONS FOR SELLING ADULTERATED OR MISBRANDED ARTICLES OF FOOD OR DRUGS.

Be it enacted, etc., as follows:

SECTION 1. No dealer shall be prosecuted under the provisions of sections sixteen to twenty-six, inclusive, of chapter seventy-five of the Revised Laws, or of any act supplementary thereto or amendatory thereof, for selling, exposing for sale, or having in his custody or possession with intent to sell, any article of food or any drug or medicine which has been adulterated or misbranded contrary to the laws of this commonwealth, or which contains any substance, the use of which in food or in drugs is forbidden by the laws of this commonwealth, if he can establish a guaranty signed by the manufacturer, wholesaler, or jobber within this commonwealth from whom he purchased the said article, drug or medicine, to the effect that the same is not adulterated or misbranded within the meaning of this act, designating the act. Such guaranty, to afford protection, shall contain the name and address of the party or parties making the sale of such articles to such dealer, and in that case such party or parties shall be subject to the prosecution, fine or other penalties which would attach in due course to the dealer under the provisions of the sections aforesaid.

SECTION 2. So much of chapter seventy-five of the Revised Laws as is inconsistent herewith is hereby repealed.

SECTION 3. This act shall take effect upon its passage.

Approved April 14, 1911.

CHAPTER 638, ACTS OF 1911.

AN ACT MAKING APPROPRIATIONS FOR THE BOARD OF REGISTRATION IN PHARMACY.

Be it enacted, etc., as follows:

SECTION 1. The sums hereinafter mentioned are appropriated, to be paid out of the treasury of the commonwealth from the ordinary revenue, for the salaries and expenses of the board of registration in pharmacy, for the fiscal year ending on the thirtieth day of November, nineteen hundred and eleven, to wit: —

For the salaries of the members, thirty-one hundred dollars.

For travelling and other expenses of the members, a sum not exceeding seventeen hundred and twenty-five dollars.

For the salary and expenses of the agent, a sum not exceeding twenty-two hundred dollars.

For a stenographer, witness fees, and incidental and contingent expenses, to include the printing of the annual report, a sum not exceeding seventeen hundred dollars.

SECTION 2. This act shall take effect upon its passage.

Approved July 7, 1911.

Public Document **No. 57**

ELEVENTH ANNUAL REPORT

OF THE

METROPOLITAN WATER AND SEWERAGE BOARD.

For the Year 1911.

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METROPOLITAN WATER AND SEWERAGE BOARD.

To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan Water and Sewerage Board, established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the fiscal year ending on November 30, 1911, and now, in accordance with the provisions of chapter 235 of the Acts of the year 1906, it presents a detailed statement of its doings for the calendar year ending on December 31, 1911, being its

ELEVENTH ANNUAL REPORT

made since the consolidation of the Metropolitan Water Board and the Board of Metropolitan Sewerage Commissioners on March 20, 1901.

I. ORGANIZATION AND ADMINISTRATION.

(1) BOARD, OFFICERS AND EMPLOYÉS.

The term of office of Henry P. Walcott, M.D., expired on March 21, 1911, and he was reappointed for the three years next succeeding. The membership of the Board has consequently remained as in the preceding year: Henry H. Sprague, chairman, Henry P. Walcott, M.D., and James A. Bailey, Junior. William N. Davenport has continued as secretary and in charge of the auditing department. Alfred F. Bridgman has been the purchasing agent and Miss Alice G. Mason the bookkeeper.

There are also employed in the administrative office a paymaster, an assistant in auditing, two general clerks, three stenographers and clerks, a telephone operator, a messenger, and a janitor with two assistants, one of whom acts as watchman.

Such general conveyancing work and investigation of real estate titles in the different counties as has been called for during the year has been performed by George D. Bigelow and Miss Alline E. Marcy.

The consulting engineers of the Board are Hiram F. Mills and Frederic P. Stearns, who are called upon for services when matters arise which require such consideration.

Dexter Brackett, Chief Engineer of the Water Works, has had supervision over the various departments of both construction and maintenance. William E. Foss has been Assistant to the Chief Engineer and has exercised a general charge over engineering work in all departments. The following have also acted under the direction of the Chief Engineer: Elliot R. B. Allardice, Superintendent of the Wachusett Department; Charles E. Haberstroh, Superintendent of the Sudbury and Cochituate Works and of the portion of the Weston Aqueduct above the Weston Reservoir; Samuel E. Killam, Superintendent in charge of the Weston Reservoir and the remaining portion of the Weston Aqueduct and of all reservoirs and pipe lines within the Metropolitan District; and Arthur E. O'Neil, Superintendent of the several pumping stations.

There has been a slight decrease in the number of the engineering force during the past year. The average force employed on construction and maintenance during the year has included, in addition to the Chief Engineer, 4 department superintendents, 2 division engineers, 8 assistant engineers, and 35 others in various engineering capacities and as sanitary inspectors, clerks, stenographers and messengers, the total force numbering 50. The maximum engineering force employed at any one time during the year on both construction and maintenance was 57.

A maintenance force in addition to those engaged in engineering capacities, as above mentioned, numbering upon the average during the year 225, has been required at the pumping stations, upon reservoirs, aqueducts, pipe lines, and upon minor construction work. At the end of the year this force numbered 219.

William M. Brown, Chief Engineer of the Sewerage Works, has had charge of both construction and maintenance. He has been assisted during the year by Frank I. Capen and Frederick D. Smith, Division Engineers, who have been in supervision of both construction and maintenance departments of the North and South systems, by Henry T. Stiff, Division Engineer in charge of the office and drafting, by 1 assistant engineer and by 10 others employed in various engineering capacities and by two clerks and stenographers.

The maximum engineering force employed at any one time during the year on construction and maintenance of Sewerage Works was 17.

The regular maintenance force required in addition for the operation of the pumping stations, the care and inspection of the sewers, and for other parts of the Sewerage Works, exclusive of the engineers and day-labor forces, has upon the average numbered 159.

The whole regular force of the Sewerage Department at the end of the year numbered 178, of whom the Chief Engineer and 12 assistants and draftsmen were engaged in general upon the works, and, of the remainder, 99 were employed upon the North System and 66 upon the South System.

The day-labor forces under the supervision of the engineers and the immediate direction of the foremen have been employed during the year in connection with the extension of the East Boston pumping station and its equipment, and in the building of the locker and stable buildings at East Boston.

The maximum number of men employed upon contracts and upon day-labor construction on the Sewerage Works during the year was for the week ending September 9, when the number amounted to 99.

(2) Offices and Buildings.

The offices of the Board and the secretary, and of the auditing and conveyancing departments, and the main engineering offices of both Water Works and Sewerage Works, are located in the buildings numbered 1 and 3 Ashburton Place, at the corner of Somerset Street, in Boston.

The headquarters of the Wachusett Department of the Water Works are at the gate and power house at the Wachusett Dam, in Clinton. The branch office for the Sudbury Department is maintained at South Framingham. Headquarters of the maintenance force of the Water Works for the northern part of the Metropolitan

District are maintained in the Glenwood pipe yard in Medford, where there are offices, shops, store-rooms and stables; and the maintenance force for the southern part of the District has headquarters in like buildings at the Chestnut Hill Reservoir.

Branch headquarters of the maintenance and repair forces of the Sewerage Works are maintained for the North Metropolitan System at the stable and locker building at East Boston and at the Deer Island pumping station, and for the South Metropolitan System at the Ward Street pumping station and at the storage yard at Hough's Neck.

II. METROPOLITAN WATER DISTRICT.

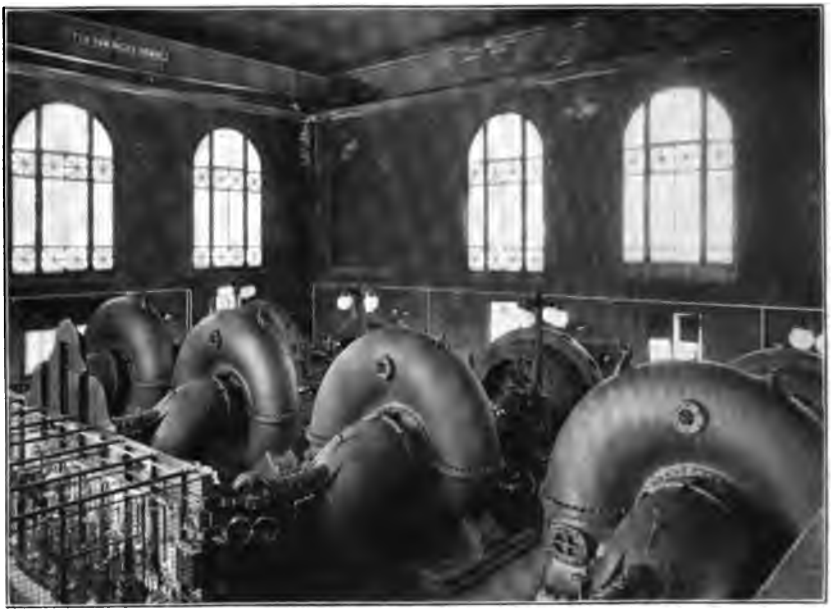
The Metropolitan Water District now comprises the cities of Boston (including by annexation the former town of Hyde Park), Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy and Somerville, and the towns of Arlington, Belmont, Lexington, Milton, Nahant, Revere, Stoneham, Swampscott, Watertown and Winthrop, — in all 9 cities and 10 towns. The District has an area of 174.8 square miles, no additional municipalities having been admitted into the District during the year. Its population, according to the United States Census taken for April 1, 1910, was 1,070,256. The population of the District on July 1, 1911, the date upon which calculations for the Water Works are based was estimated as 1,101,930.

The city of Newton and the town of Hyde Park, though belonging to the District, did not take water from Metropolitan sources during the year 1911, but the section formerly constituting the town of Hyde Park will be furnished with water during the year 1912.

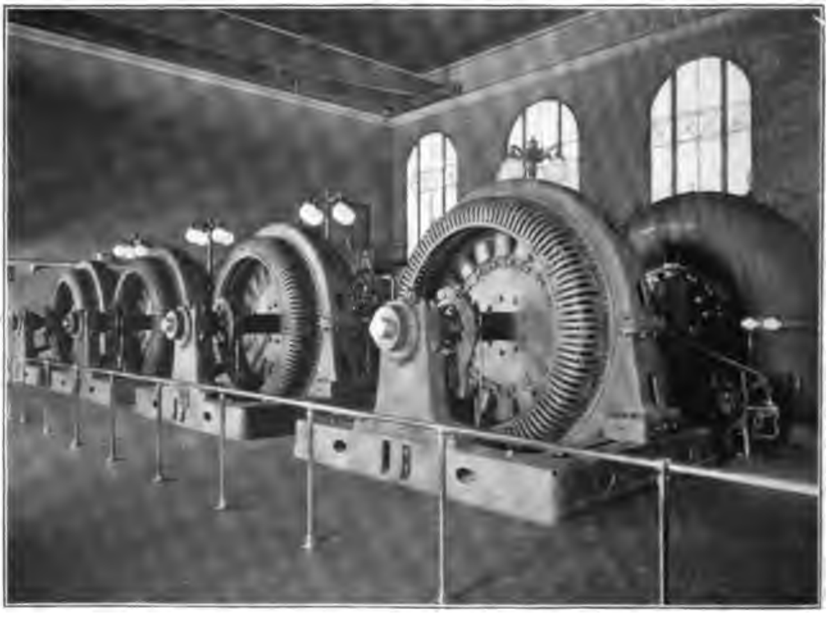
III. METROPOLITAN WATER WORKS — CONSTRUCTION.

The total amount expended for the construction and acquisition of the Metropolitan Water Works since the passage of the Metropolitan Water Act in the year 1895 has been $41,932,850.44.

The total amount expended during the calendar year on account of the construction and acquisition of works has been $385,920.88. There has been expended on account of the Wachusett power plant the sum of $112,564.42; for the improvement of the Wachusett watershed, the sum of $4,505.95; in the laying of the new 60-inch main for bringing the supply of water from the Weston Aqueduct



WACHUSETT POWER PLANT—VIEW OF THE FOUR HYDRAULIC TURBINES.



WACHUSETT POWER PLANT—VIEW OF THE FOUR ELECTRIC GENERATORS.

into the Metropolitan District, the further sum of $70,589.92; for the reinforcement of the supply of East Boston, the further sum of $19,564.92; on account of the new pumping engine which has been installed at Chestnut Hill pumping station for the use of the southern high-service district, $60,874.71; in the laying of a new main to Hyde Park and on account of the construction of a new pumping station, the sum of $107,824.97; and for other minor works, engineering and administration expenses, the remaining sum of $9,995.99.

(1) WACHUSETT POWER PLANT.

The machinery for utilizing the fall of the water at the Wachusett Dam for the development of power has been installed during the past year in the large gate and power house erected at the foot of the dam. In accordance with the contracts which had been made in the preceding year four large hydraulic turbines with four electric generators have been introduced, each turbine being guaranteed to develop 1,200 horse power with an average efficiency a little exceeding 80 per cent. The machinery is provided with an adequate equipment of valves, governors, switchboard, recording instruments and other necessary apparatus for the development and transmission of power.

The water for supplying the turbines is introduced through vertical chambers and wells originally constructed in the dam, through which it falls to a depth of about 111 feet below the line of high water in the reservoir, and is thence conveyed in pipes to the turbines from which it is afterward discharged into the Wachusett Aqueduct.

The power generated is conveyed from the power house by underground cable for a distance of 815 feet to a point near the Central Massachusetts Railroad, where a building, 20 feet long and 14 feet wide, has been erected to contain the necessary apparatus for the protection of the power house and its machinery against lightning currents, and whence the power is transmitted by an overhead pole line for about 600 feet to a connection with the line of the Connecticut River Transmission Company. At this connection the electric energy developed is delivered to the Transmission Company in accordance with a five-year contract made with the Company in the preceding year.

It is anticipated that a total, equivalent to an average of about 2,500 horse power, will be delivered to the Company, but the amount will necessarily vary according to the quantity of water required to be introduced into the Wachusett Aqueduct for the supply of the Metropolitan District, and according to the necessity of conserving the Wachusett water supply and utilizing the other sources of supply from which water is drawn for the District.

The work was completed so that the Board was able to begin to furnish power to the Connecticut River Transmission Company on August 10, 1911.

(2) Improvement of the Watersheds.

For the better protection of the waters of the Wachusett Reservoir the Board has acquired during the year several parcels of land containing in all 125.5 acres and situated in the towns of West Boylston and Sterling. The lands acquired lie on both sides of Waushacum Brook which runs from Waushacum Pond to the reservoir and is one of the principal feeders of the reservoir. They are generally of a swampy nature, in unsatisfactory condition, and would if occupied by dwellings afford a particular menace to the water supply.

Two other tracts having an area of about five acres, situated in Boylston on the margin of the Wachusett Reservoir, were acquired by exchange.

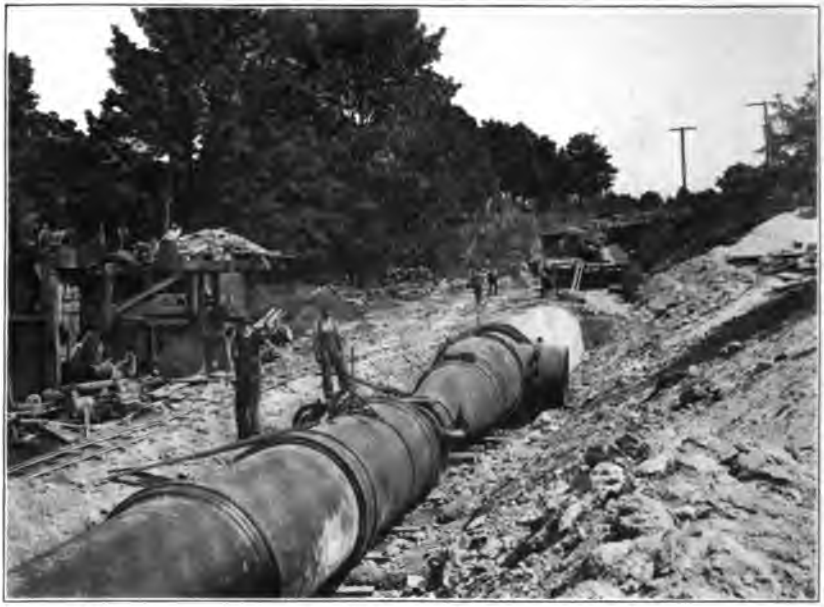
About one and a half acres in the town of Framingham were acquired for the protection of Framingham Reservoir No. 2, as their situation upon the shores of the reservoir and near the thickly settled portions of the town offered particular inducement to purchasers for building purposes.

A further small parcel in Natick of about one-fifth of an acre was acquired and added to the margin about Lake Cochituate where the shore was exposed.

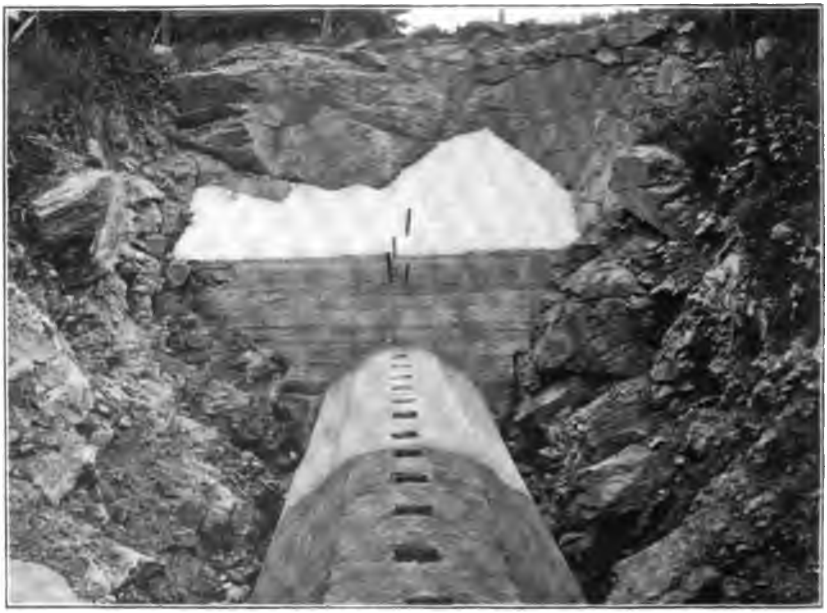
(3) Distribution System.

(*a*) *Additional Weston Aqueduct Supply Main.*

During the last year a section about 2,700 feet long of the additional supply main which is to connect the terminus of the Weston Aqueduct with the Chestnut Hill Reservoir, has been completed,



WESTON AQUEDUCT SUPPLY MAIN—60-INCH CAST-IRON PIPE CONNECTED BY VALVE WITH 80-INCH CONCRETE-COVERED STEEL PIPE AT ENTRANCE TO NEWTON TUNNEL.



WESTON AQUEDUCT SUPPLY MAIN—JUNCTION OF 80-INCH CONCRETE-COVERED STEEL PIPE WITH 76-INCH CONCRETE MAIN IN TUNNEL.

so that now, of the entire length of about 34,650 feet, all the lower portion of the line for a distance of about 20,260 feet, ending with the mains near the Chestnut Hill Reservoir, has been constructed.

The most important part of the work accomplished during the past year was in connection with the tunnel which extends for a distance of a little more than 2,000 feet through a hill in the northeasterly part of the city of Newton. The rock excavation for the tunnel had been made in the preceding year, but there remained principally to be performed the concreting of the excavation for the making of the 76-inch tunnel and the making of connections at each end of the tunnel with the 60-inch iron pipes by lengths of about 180 feet of 80-inch steel pipes. The tunnel has been constructed of sufficient size to be available for another supply line in the future.

The portion of the main line completed was put into service of the water supply on November 4, 1911.

(*b*) *New Supply Main for East Boston.*

The laying of the 36-inch pipe in the tunnel under Chelsea Creek, which had been built in the previous year in order to make a further connection between East Boston and the Metropolitan Main in Chelsea, was completed, and the spaces between the pipes and the brick lining of the tunnel were filled with cement concrete. The new line was put into service on February 17, 1911, and a much-needed protection was afforded to the East Boston section in case trouble should arise with the two old mains, upon which its supply depended.

(*c*) *New Pumping Engine at Chestnut Hill.*

The new pumping engine for the southern high service has been fully installed in the Chestnut Hill pumping station and was placed in service on March 27, 1911, but the final test has not yet been made. It is capable of pumping 40,000,000 gallons per day with a lift of 130 feet.

(*d*) *Supply of Water to Hyde Park.*

Although the town of Hyde Park was included in the Metropolitan Water District it had hitherto depended upon its own sources of supply and had not been furnished with water from the Metropolitan Works. On March 28, 1911, however, it called upon the Board to furnish it with a water supply, which the town was entitled to receive upon its application under the Metropolitan Water Act. An appropriation of $212,000 for the necessary expenses of extending the system to that town was subsequently made by the Legislature and the work of construction was immediately begun.

A line of 24-inch pipe has been laid from a connection with the main line at Forest Hills in Roxbury to a point in Hyde Park near the boundary line, a distance of 10,200 feet, and from this point a further 20-inch line has been laid for a distance of 6,700 feet to make connection with the Hyde Park system in the central part of the town. Both these lines had been completed so as to be ready to furnish a supply to Hyde Park at the beginning of the year. The water which is thus supplied will be furnished at a pressure less than that which is desirable for the higher sections, and the proposed extension includes the erection of a pumping station near the boundary line at the junction of the two new mains. The necessary land has been purchased, extending from Hyde Park Avenue to the railroad, where a switch track will be laid for the delivery of coal to the station. Work has been begun upon foundations of the structure, and a contract has been made for two pumping engines, each having a capacity for pumping 3,000,000 gallons in 24 hours.

A 20-inch pipe line has also been laid, about 3,000 feet long, from the pumping station to connect with a main of the city of Boston in West Roxbury, by which water can be pumped from this station to supply the higher portions not only of Hyde Park, which has now become a part of the city of Boston, but also of West Roxbury and Milton.

It is expected that the pumping station will be completed and equipped and put into operation before the end of the year.

(4) ACQUISITION OF LANDS AND SETTLEMENTS FOR DAMAGES.

The Board has acquired by purchase during the past year additional lands in fee amounting to 133.472 acres and has acquired by taking, easements in 0.383 of an acre. The total acquisitions of land in fee and in easement have thus amounted to 133.855 acres.

Of the lands acquired, three tracts containing 80.788 acres in West Boylston and Sterling, were situated on Waushacum Pond and

Brook; one tract containing 44.75 acres was situated on French Brook in Boylston; two tracts situated partly in Hyde Park and partly in Boston, containing 1.421 acres in fee and easements in another parcel of 0.383 of an acre, were acquired in order to provide for the laying of a pipe line, and for the erection of a pumping station for the Southern High Service; a parcel of land containing 0.21 of an acre in Natick was situated on the margin of Lake Cochituate; and a parcel containing 1.433 acres in Framingham was on Framingham Reservoir No. 2. Two remaining tracts in Boylston having an area of 4.88 acres were acquired by exchange.

The Board has conveyed away in exchange a small parcel of land in Boylston, containing 0.32 of an acre, and has granted to the Worcester County Commissioners the right to use, subject to revocation, 22 acres of land on Pleasant Street in West Boylston for forestry and agricultural purposes in connection with the Worcester County Training School.

The settlements made during the year on account of land both purchased and taken have numbered 9. The total amount paid in settlements was $12,229.03. All of these settlements were effected by voluntary agreement.

There have been 5 takings of land in fee, including a total of 54.219 acres, all of which were of parcels to which title by deed had previously been acquired, and there was made an additional taking of easements and rights in 0.383 of an acre which had not been previously acquired. Takings of temporary rights of way and occupancy of lands in Newton, in all of 3.569 acres, were made for the purpose of constructing a tunnel in connection with the Weston Aqueduct Supply Mains.

The following is a list of the takings made during the year for the Water Works: —

Takings for Metropolitan Water Works for the Year 1911.

No.	Location and Description.	Former Owner.	Recorded.	Purpose of Taking.
			1911.	
137	West Boylston and Clinton, — Laurel Street in West Boylston, on West Berlin road, Clinton. Area, fee in 9.245 acres.	Anna E. Russell, Lucinda E. Larkin.	May 20.	Improvement of Wachusett watershed.
138	Holden,—Tietze mill property. Area, fee in 42.12 acres.	Abel C. Haynes.	May 20.	Improvement of Wachusett watershed.
139	Newton, — Additional rights of way and to occupy in extension of same rights taken May 12, 1910, relating to lands near Commonwealth and Grant avenues and Ward Street. Area, right to occupy, 2.99 acres, rights of way in 0.579 acre.	John Ward and heirs of George K. Ward, heirs of Francis Pettee, Nehemiah W. Rice *et al.*, Caroline R. Braman, Charles G. Rice.	Sept. 1.	Weston Aqueduct supply mains.
140	Hyde Park, — Hyde Park Avenue and easements in railroad location and Mansur Street and Grew Avenue. Area, fee in 1.276 acres, easements in 0.128 acre.	Eva M. Nesson, Carl Stohn and easements in location of New York, New Haven & Hartford R.R. and private ways.	Sept. 9.	Southern high-service pipe lines.
141	Boston (West Roxbury), — Parcel adjoining location of New York, New Haven & Hartford R.R. Co., westerly from Hyde Park Avenue and easements in Mansur and Burley streets. Area, fee in 0.145 acre, easements in 0.255 acre.	Eva M. Nesson and easements in private ways.	Sept. 9.	Southern high-service pipe lines.
142	Framingham, — Between Fountain Street and location of Boston & Albany R.R. Co. Area, fee in 1.433 acres.	Bridget McLaughlin and Mary Gallagher.	Nov. 24.	Framingham Reservoir, No. 2.

IV. WATER WORKS — MAINTENANCE.

(1) Operation of Works.

The maintenance and operation of the Metropolitan Water Works during the past calendar year has required the expenditure of $362,819.46.

(2) Storage Reservoirs.

The following reservoirs are maintained for the collection and storage of water in the various watersheds which serve as sources of supply for distribution to the different municipalities in the District: —

	Capacity in Gallons.
Cochituate watershed: —	
Lake Cochituate, including Dudley Pond,	2,328,300,000
Sudbury watershed: —	
Sudbury Reservoir,	7,253,500,000
Framingham Reservoir No. 1,	287,500,000
Framingham Reservoir No. 2,	529,900,000
Framingham Reservoir No. 3,	1,180,000,000
Ashland Reservoir,	1,416,400,000
Hopkinton Reservoir,	1,520,900,000
Whitehall Reservoir,	1,256,900,000
Farm Pond,	167,500,000
Wachusett watershed: —	
Wachusett Reservoir,	64,968,000,000
Total,	80,908,900,000

The various reservoirs are capable of holding in storage 80,908,900,000 gallons, but their full capacity was not reached during the year. At the beginning of the year the total quantity in storage was 59,327,000,000 gallons. The maximum quantity in storage was reached on May 2, when there were contained 67,953,900,000 gallons, a quantity less than that in any preceding year since the Wachusett Reservoir was first filled. The quantity decreased until October 18, when there were 55,503,900,000 gallons. During the latter part of the year there was a gain in storage so that on January 1, 1912, the reservoirs contained 59,980,000,000 gallons, or somewhat more than the quantity held at the beginning of the year.

At the Wachusett Reservoir high-water mark was not reached, the highest elevation of water at any time being on June 10, when the elevation was 387.41 feet, or 7.6 feet below the high-water mark of the reservoir. At the end of the year, however, the reservoir was nearly 3 feet higher than at the beginning.

Little work has been required upon the margins of the Wachusett Reservoir, but the carrying of materials and machinery in connection with the installation of the power plant at the Wachusett Dam has so worn the roadways that considerable repairs have been required. The work has been done in conjunction with the authorities of the town of Clinton and the various ways have been restored to good condition.

A small concrete building has been erected on the grounds below the Wachusett Dam for use as a garage and for a storehouse for tools used in the care of the grounds.

The Sudbury Reservoir, which receives the supply from the Wachusett Reservoir, and Framingham Reservoir No. 3, into which a portion of the Sudbury waters is discharged, were kept full or nearly full during the year in order to facilitate the furnishing of the supply to the Metropolitan District.

On account of the desire to utilize so far as practicable during the past year the waters of the Ashland, Hopkinton and Whitehall reservoirs, as well as those of Framingham Reservoir No. 2, these reservoirs have been drawn upon for considerable periods for the Metropolitan supply.

No water has been drawn from Framingham Reservoir No. 1 or from Farm Pond for Metropolitan uses, although the town of Framingham has obtained the larger part of its supply from filter galleries located on the shores of Farm Pond.

Lake Cochituate was drawn upon during the larger portion of the year for the supply of the Metropolitan District. Some further land has been acquired for increasing the margin about the lake, and a low, shallow area on the shore has been filled. The general improvement by which the surface drainage from the village of Cochituate is diverted into Bannister's Brook and the Sudbury River has been completed.

(3) AQUEDUCTS.

The Wachusett Aqueduct, through which is carried the water from the Wachusett Reservoir into the Sudbury Reservoir, was in operation a total of 198 days in the year. An average of 65,580,000 gallons per day for the entire year was drawn from the reservoir, which was less than two-thirds of the quantity drawn in the preceding year, on account of the greater utilization of the other sources of supply.

The Sudbury Aqueduct was in constant use during the year and discharged into the Chestnut Hill Reservoir 70,560,000 gallons per day, 47,768,000 gallons being drawn from the Sudbury Reservoir through Framingham Reservoir No. 3, and 22,792,000 gallons from Framingham Reservoir No. 2.

The Cochituate Aqueduct was in operation for 210 days during the year and the quantity drawn was equivalent to a daily average of 9,522,000 gallons for the entire year.

With the exception of 1½ hours on a single day the Weston Aqueduct was in continuous service and there was an average daily flow of 29,839,000 gallons for the year.

It therefore appears that a greater use has been made during the past year of the waters of both Framingham Reservoir No. 2 and the contributing reservoirs in the southern part of the Sudbury watershed, and also of the waters of Lake Cochituate which, on account of the works in progress, were not utilized at all for the Metropolitan District in the preceding year.

(4) Distributing Reservoirs.

The various distributing reservoirs and standpipes have been kept substantially full during the year not only as a protection and relief in case of accident and emergency, but also in order to secure a proper distribution of the water through the District.

Their respective locations in the different parts of the Metropolitan District and their capacities are as follows: —

	Capacity in Gallons.
Spot Pond, Stoneham and Medford,	1,791,700,000
Chestnut Hill Reservoir, Brighton district of Boston,	300,000,000
Weston Reservoir, Weston,	200,000,000
Fells Reservoir, Stoneham,	41,400,000
Mystic Reservoir, Medford,	26,200,000
Waban Hill Reservoir, Newton,	13,500,000
Forbes Hill Reservoir, Quincy,	5,100,000
Bear Hill Reservoir, Stoneham,	2,450,000
Arlington Standpipe, Arlington,	550,000
Forbes Hill Standpipe, Quincy,	330,000
Total,	2,381,230,000

(5) Pumping Stations.

Of all the water supplied to the various municipalities of the Metropolitan District 73 per cent., or nearly three-quarters, is brought to Chestnut Hill and pumped from the Chestnut Hill pumping stations. The remaining 27 per cent. is delivered by gravity into the large mains of the District. Some of the higher portions of the District are supplied by a second pumping from the Spot Pond, Arlington and West Roxbury stations.

The average quantity pumped per day during the year at the Chestnut Hill stations was 80,435,000 gallons, at the Spot Pond station 7,590,000 gallons, at the Arlington station 835,000 gallons, and at the West Roxbury station 690,000 gallons, a total of 89,550,000 gallons a day being upon the average pumped at all the stations.

The following are the several pumping stations: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Chestnut Hill High-service Station,	4	66,000,000	138
Chestnut Hill Low-service Station,	3	105,000,000	60
Chestnut Hill Low-service Station,	1	40,000,000	130
Spot Pond Station,	2	30,000,000	125
Arlington Station,	2	3,000,000	290
West Roxbury Station,	3	3,750,000	140

The total cost of operating all of the stations during the year was $97,196.68, or $2.97 per million gallons pumped, which is a slight decrease from the cost of the preceding year. Of the total cost, $58,596.44 was expended for labor and $33,197.54 for fuel.

The total amount of coal purchased during the year was 10,034.88 gross tons, of which 7,277.16 tons were bituminous, 100.93 tons anthracite, 2,107.10 tons buckwheat anthracite and 549.69 tons anthracite screenings. The average cost of bituminous coal delivered in the bins at the various stations varied from $3.90 to $4.46; the average cost of anthracite coal was $5.17; the cost of buckwheat varied from $2.69 to $4.37, and that of anthracite screenings from $2.50 to $2.72.

A change was made in the requirements of the contracts for the purchase of bituminous coal by which the number of heat units required was increased and the allowable percentage of ash was decreased. An improvement in the quality of the coal furnished resulted. The contracts for furnishing coal continue to provide that a deduction shall be made when the coal falls below the requirements and at the same time the price is increased if it is found superior to the requirements.

A new pumping engine for the high service, which is located in the low-service pumping station, has been in operation the latter part of the year.

(6) PIPE LINES.

The total length of the pipe lines owned and operated by the Board is 101.58 miles, the length of 4.56 miles having been added during the year. The Metropolitan mains are connected with local mains by which the water is distributed to the various municipalities of the District, and these local mains of 4 inches and more in diameter have a total length of 1,569.92 miles.

During the year the abolishment of the grade crossing of the Fitchburg Railroad at Webster Avenue in the city of Somerville made necessary a change in the main 48-inch pipe line which had been laid through Webster Avenue. It was necessary to raise a length of about 983 feet, and the line for this distance has been carried over the railroad on a permanent steel bridge. The pipes were raised about 17 feet at the railroad crossing. The work was performed in connection with the Boston & Maine Railroad, the more difficult parts of the work being performed directly by the Board. The entire cost of the work, including both the portion done by the Board and that done by the Railroad, was $15,616.42. For its expenditure the Board was reimbursed by the parties charged with the expense of the improvement.

The construction of a larger channel for Stony Brook at Morton Street in West Roxbury by the City of Boston compelled the building of piers for the support of the 36-inch water main which crosses the channel at this point.

No serious break in any of the pipe lines occurred during the past year, but there were 43 leaks of a minor character which have required repairing. Of these leaks 36 were due to defective joints, some at wooden joints but the larger part at leaded joints.

(7) CLINTON SEWERAGE WORKS.

The Clinton pumping station was in operation during the entire year, and though there was a considerable extension of the sewerage system in the town, the average quantity of sewage daily pumped to the filter-beds was 829,000 gallons, the same as last year. The total cost of pumping the sewage was $3,014.85, or $9.97 per million gallons pumped.

There has been an improvement in the efficiency of the filter-beds, effected by the recent construction of additional underdrains and the placing of distributors on the beds in order to secure a uniform distribution of the sewage, and the results show a decided improvement in the effluent.

The cost of maintaining the filter-beds was $3,797.52, or $12.63 per million gallons treated. The increase of the cost was due to the required increase in the rates paid to laborers.

(8) PROTECTION OF THE WATER SUPPLY.

(*a*) *Diversion of Surface Drainage from Lake Cochituate.*

The works which have been in progress of construction for the diversion of the surface drainage which had found its way into Lake Cochituate were completed early in the year, and the drainage is now carried to Bannister's Brook from which it flows into the Sudbury River. The work involved the building of an open channel of 5,876 feet, a channel covered with concrete for 3,454 feet, and the laying of 1,491.5 feet of 24-inch, 18-inch and 12-inch pipe. The total cost of the work was $34,558.02 and was charged to the appropriation for maintenance.

(*b*) *Improvement of the Wachusett Watershed.*

In addition to the acquisition of low lands situated upon Waushacum Brook, through which the waters of Waushacum ponds are carried into the Wachusett Reservoir, for the protection of the water supply the brook itself has been straightened, deepened and widened, and generally improved on both sides.

(*c*) *Pegan Brook Filtration Works.*

The Pegan Brook pumping station, at which is pumped the surface drainage of the thickly settled portion of the town of Natick upon filter-beds on the margin of Lake Cochituate, was in operation 193 days during the year, and a daily average of 605,310 gallons was pumped. The cost of operating the pumping station and filter-beds was $2,731.18, a cost per million gallons filtered of $12.36.

(*d*) *Marlborough Brook Filter-beds.*

The Marlborough Brook filter-beds, which have been constructed near the mouth of the Marlborough Brook as it enters the Sudbury River, are 24 in number, 16 of them being artificial beds and 8 natural beds, and they have an area of 14 acres. These beds have been sufficient to care for the entire flow of the brook, which receives the surface water from thickly settled portions of the city of Marlborough.

(*e*) *Sterling Filter-beds.*

The filter-beds constructed on the brook which flows through the central portion of the town of Sterling and into Waushacum Pond, and the smaller filter-beds at Sterling Junction, which were built to intercept the sewage of the summer cottages and to prevent the pollution of Waushacum Pond, have been successfully operated and their care has involved but little expenditure.

(*f*) *Drainage Ditches.*

No additions have been made to the ditches which have been kept in operation in order to provide a quick drainage of several of the larger swamps on the watersheds and to prevent the discoloration and deterioration of the water flowing from them, but the existing ditches have required considerable repairs and oversight during the year.

(*g*) *Sanitary Inspection and Policing.*

A constant inspection is made of all the watersheds which contribute to the supply of water to the Metropolitan District so as to prevent the existence of sources of pollution. All premises which seem to be subject to conditions which might be injurious are kept under surveillance and it is sought to remedy the troubles which are found to exist. In many cases remedies are effected by removing the cause of the pollution, by causing connections to be made with the sewers, by the building of cesspools and otherwise. There are other cases where complete remedies are more difficult and where temporary arrangements have to be made until more comprehensive measures can be adopted. At the end of the year the premises are reported as " unsatisfactory ", unless effective means have been taken to secure the prevention of pollution, or if the premises continue a menace which will require continued attention.

The great industrial development of sections of Framingham during the past year has caused the erection of many buildings on tracts where the disposal of the sewage by cesspools is difficult, and an extension of the local sewerage system is urgently called for in preventing a future pollution of the water supply.

Examination has been made of 1,515 premises on the Wachusett watershed and of 7,235 premises on the Sudbury and Cochituate watersheds, and reports have been made thereon with reference to cesspools, privy, sink and barn drainage, manufacturing wastes and sewer connections. At the end of the year it was reported that 66 of the premises in the Wachusett watershed and 113 premises in the Sudbury and Cochituate watersheds were regarded as unsatisfactory, that is, that trouble might possibly arise under unfavorable circumstances and that they required further attention.

A comparison of the tables which are furnished in the report of the Chief Engineer with those of past years would indicate that there has been a gradual improvement in the sanitary condition of the watersheds.

There were 9 cases of typhoid fever reported from the Wachusett watershed and 33 cases on the Sudbury and Cochituate watersheds. In all these cases precautions were taken to prevent the spread of the disease and the pollution of the water supply, and no trouble was experienced from them.

The sanitary inspection has been performed by William W. Locke, C.E., with two assistants, but other employés of the Board have been called upon at various times during the year to inspect conditions in different parts of the watersheds and also for the more general protection of the property of the Commonwealth.

(*h*) *Laboratory Examinations.*

Chemical examinations are made at monthly or more frequent periods by the State Board of Health of the waters in various storage reservoirs at different depths and places and of the water discharged from the pipes in various parts of the Metropolitan District, and report is made to the Metropolitan Board relative to the amounts not only of nitrogen and other substances but turbidity, sediment and color. More frequent examinations of the water taken from the various sources are made at the laboratory of the Metropolitan Board to ascertain the numbers and character of microscopical organisms contained in the various waters. The results are used both for determining the sources from which water shall be drawn from time to time for consumption and for the purpose of taking such measures as may be possible to remedy the troubles found to exist. During the past year 397 chemical examinations were made by the State Board and 2,465 microscopical and 1,174 bacterial examinations were made by the Metropolitan Board.

(9) QUALITY OF THE WATER.

The water supplied to the Metropolitan District has generally been of good quality and very few complaints have been received from water takers. Owing to the fact that a larger quantity than usual has been drawn from the Sudbury and Cochituate sources the water has had a higher color than in some previous years. The growths of microscopical organisms and bacteria have been less and not of sufficient extent to cause objectionable tastes and odors in the water as drawn from the pipes throughout the District.

(10) FORESTRY AND MOTH SUPPRESSION.

It has been the policy of the Board to protect the waters of the Wachusett Reservoir by surrounding the shores by an adequate margin at least of wooded growth. In addition to the 1,800 acres already wooded, out of a total of about 4,500 acres originally acquired, 1,350 acres have been planted by the Board, principally with pines and arbor vitae seedlings. There remain about 520 acres which it is proposed to plant. During the past year, however, only about 30 acres have been newly forested, largely owing to the fact that the older nurseries have ceased to yield proper seedlings on account of exhaustion. It has been necessary to replant with new seedlings about 12.5 acres on which the trees had been destroyed by fire. The undesirable trees and brush have also been cut out on 55 acres of the land which had been previously planted with pines, and considerable thinning out of the growth has been made on a like number of acres covered with a growth of older trees.

The Flagg nursery on the south side of the reservoir has been abandoned and the land planted with white pines. There still remains a small number of arbor vitae seedlings in the Lamson nursery on the north side of the reservoir, although the larger part of the tract has also been covered with pines.

The new nursery which has been started in Oakdale now contains more than 50,000 white pine seedlings.

During the past year there have been, owing to the prevailing drought, several serious fires upon the lands of the Commonwealth in the custody of the Board. As many as 21 fires were reported upon the Wachusett watershed, and an area of more than 230 acres was burned over. These fires were particularly destructive to the small pine trees which had been planted and had attained a considerable growth. The damage occasioned was estimated at nearly $4,000, and more than three-fourths of this amount was collected from the railroad companies which were found liable for the larger part of the fires. There were 7 fires on lands surrounding the Sudbury Works and about 45 acres were burned over, but the loss occasioned was not so great.

The forest growth has suffered severely from the ravages of the gypsy and brown-tail moths and the elm-leaf beetle and pine-tree weevil, and the sum of $7,062.21 has been expended for the protection of the various lands under the custody of the Board. The region about Spot Pond has been the most infested, although the injuries have not exceeded those of past years. Much work has been called for in the vicinity of the Weston Reservoir and along the Sudbury and Wachusett aqueducts and about the Wachusett Reservoir. It has been deemed advisable to expend a considerable sum for the purchase of a large and efficient power sprayer, which has been effectively used especially in the region about Spot Pond and the Chestnut Hill and Weston Reservoirs.

It has been the endeavor to attend to the regions most infested by the moths and especially those places where the adjoining properties are cared for by their owners. It is impossible to extend the work of suppressing the moths to the more remote and extensive woodlands without calling for large appropriations. A good deal has been accomplished in the destruction of the gypsy moths, but the work of protection against the brown-tail moths has been unsatisfactory on account of the distances which they fly.

The pine-tree weevil has infested the lands about the Sudbury and Wachusett reservoirs, and much work has been done in cutting off and burning the shoots of the young pines which have been found infested. There seems to have been less injury done than during the previous year. The chestnut bark disease was discovered in the latter part of the year in the chestnut trees near the Wachusett Dam and the disease seems to have extended through many of the towns upon the Wachusett and Sudbury watersheds. Many trees have already been destroyed and it would seem that all of the chestnut trees would have to be sacrificed.

(11) ELECTROLYSIS.

There has been no substantial change taking place in relation to the injury which is occasioned to the pipe lines through the passage of currents of electricity. The various means which have been adopted, particularly the installation of wooden insulating joints on the pipe lines, to overcome or to check the troubles arising have certainly checked the injurious action at the points which have been most exposed. There have been noticeable increases in the electric currents in places where the new power stations have been put in operation near the pipe lines.

V. WATER WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, disbursements, assets and liabilities of the Board for the State fiscal year, beginning with December 1, 1910, and ending with November 30, 1911, was, in accordance with the requirements of chapter 235 of the Acts of the year 1906, presented to the General Court in January last, and a copy of this financial abstract is printed as Appendix No. 5.

The more detailed statement of its doings required by said chapter for the calendar year 1911 in relation to the Metropolitan Water Works, is herewith presented.

The Metropolitan Water Loans authorized for the construction and acquisition of works have amounted to $42,090,000. To this sum are added the proceeds from the sale of property by the Board, and these amounted on January 1, 1912, to $298,856.71. The total amount, therefore, which the Board has been authorized to expend is $42,388,856.71. The amount of expenditures approved by the Board for payment out of the Metropolitan Water Loan Fund was, for the year 1911, $385,920.88, and the total amount so approved for payment since the beginning of the work up to January 1, 1912, has been $41,932,850.44. There was accordingly a balance remaining at the beginning of the year 1912 amounting to $456,006.27.

The Treasurer of the Commonwealth has issued from time to time, on the request of the Board, bonds to the amount of $41,738,000. These bonds were issued for terms of thirty-nine and one-half and forty years from the date of issue, and bear interest at the rate of 3 per cent. and 3½ per cent. per annum. The sinking fund established for the payment of the bonds at maturity amounted on January 1, 1912, to $8,953,437.44.

The increase in the debt, during the calendar year, as represented by the Metropolitan Water Loans outstanding, was $340,000. The increase of the sinking fund for the payment of the debt at maturity was during the same period, $863,534.53. There has been, therefore, a decrease of the net debt during the calendar year amounting to $523,534.53.

The amount approved by the Board for the maintenance and operation of the Water Works for the year 1911 which was paid out of the annual assessments, was $362,819.46.

The assessments for the year 1911 for the payment of interest on the bonds, for the sinking fund requirements and for the expenses of operation and maintenance of the Water Works, which were levied upon the various cities and towns in the Metropolitan District, amounted to $2,333,021.97.

(1) METROPOLITAN WATER LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction and acquisition of the Metropolitan Water Works, the receipts which are added to the proceeds of these loans, the expenditures for the construction and acquisition of works, and the balance available on January 1, 1912, have been as follows: —

Loans authorized under acts prior to 1911,[1]	$41,778,000 00	
Loan under chapter 464 of the Acts of 1911, for the extension of the Southern High Service,	212,000 00	
		$42,090,000 00
Receipts from the sales of property applicable to the construction and acquisition of works: —		
For the year ending December 31, 1911,	$10,282 67	
For the period prior to January 1, 1911,	198,574 04	
	$208,856 71	
Receipt from town of Swampscott for admission to the Metropolitan Water District paid into Loan Fund (St. 1909, c. 320),	90,000 00	
		298,856 71
		$42,388,856 71
Amount approved by the Metropolitan Water and Sewerage Board for payments out of the Water Loan Fund: —		
For the year ending December 31, 1911,	$385,920 88	
For the period prior to January 1, 1911,	41,546,929 56	
		41,932,850 44
Balance January 1, 1912,		$456,006 27

(2) ISSUES OF METROPOLITAN WATER LOAN BONDS.

The Treasurer of the Commonwealth, under the authority given him to issue from time to time, on the request of the Board, negotiable bonds to an amount not exceeding $42,090,000, to be designated the "Metropolitan Water Loan," has sold bonds to the amount of $41,738,000. The list of bonds sold prior to the year 1910 is given in the Ninth Annual Report. The bonds sold in the year 1911 are as follows: —

DATE OF SALE.	Amount of Bonds sold.	Rate of Interest (Per Cent.).	Price received.	Date due.	Premium.
Jan. 30, 1911,	$200,000	3½	100.036	Jan., 1951	$72 00
Aug. 4, 1911,	40,000	3½	100.000[2]	Jan., 1951	-
Aug. 17, 1911,	100,000	3½	100.000[2]	Jan., 1951	-

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[1] For complete statement of Loans authorized prior to 1911, see Tenth Annual Report.

[2] Not issued or delivered until 1912.

Prior to May 1, 1906, all premiums received from the sales of bonds were applied to the payment of the current charges in reduction of the annual assessments, but since that date, under the provisions of chapter 337, Acts of 1906, they have been paid into the sinking fund.

(3) Metropolitan Water Loan Sinking Fund.

The sinking fund established by the Treasurer of the Commonwealth has amounted at the end of each year to sums as follows: —

December 31, 1895, .	$226,286 05	December 31, 1904, .	$3,519,602 92
December 31, 1896, .	699,860 70	December 31, 1905, .	4,207,045 69
December 31, 1897, .	954,469 00	December 31, 1906, .	4,897,822 62
December 31, 1898, .	1,416,374 29	December 31, 1907, .	5,643,575 69
December 31, 1899, .	1,349,332 97	December 31, 1908, .	6,419,283 28
December 31, 1900, .	1,573,619 72	December 31, 1909, .	7,226,262 31
December 31, 1901, .	1,662,426 95	December 31, 1910, .	8,089,902 91
December 31, 1902, .	2,256,803 81	December 31, 1911, .	8,953,437 44
December 31, 1903, .	2,877,835 59		

(4) Annual Assessments and Receipts.

Assessments for the year 1911 amounting to $2,333,021.97 were required for the payment of the interest on the bonds issued by the Commonwealth, the sinking fund requirements and the expenses of operation and maintenance of the Water Works. The requirements were: for interest, $1,415,881.26; for the sinking fund, $515,369; for serial bond, $5,000; and for maintenance and operation, $396,771.71. These assessments were made by the Treasurer of the Commonwealth upon the various municipalities as follows: —

Arlington, . . .	$18,249 50	Nahant, ...	$5,308 47
Belmont, . . .	7,439 82	Newton, ...	6,476 92
Boston, . . .	1,825,362 87	Quincy, ...	54,410 43
Chelsea, . . .	50,649 44	Revere, ...	26,022 35
Everett, . . .	47,962 56	Somerville, . .	115,094 29
Hyde Park, . .	1,288 44	Stoneham, . . .	11,255 28
Lexington, . . .	8,238 55	Swampscott, . .	10,651 30
Malden, . . .	43,828 06	Watertown, . .	18,569 01
Medford, . . .	30,159 23	Winthrop, . . .	14,819 25
Melrose, . . .	21,200 18		
Milton, . . .	16,036 02		$2,333,021 97

The comparatively smaller sums assessed upon the city of Newton and the town of Hyde Park were owing to the fact that neither of these municipalities had reached the safe capacity of its own sources of water supply, and neither had been furnished with water.

The proceeds from the operations of the Board, exclusive of the proceeds from sales of property and of water, are required by statute to be applied to the payment of the interest, the sinking fund requirements and expenses of maintenance and operation of works. These for the year 1911 amounted to $28,408.82.

The amount approved by the Board for the maintenance and operation of the Metropolitan Water Works was, for the year 1911, $362,819.46.

(5) SUPPLYING WATER TO CITIES AND TOWNS OUTSIDE OF DISTRICT AND TO WATER COMPANIES.

Sums have been received during the year 1911 under the provisions of the Metropolitan Water Act, for water furnished, as follows: —

Town of Framingham,	$1,969 15
Town of Revere (on account of water furnished to the town of Saugus for 1909 and 1910),	610 00
United States Government,	2,093 27
Town of Wakefield,	3,748 79
Westborough State Hospital,	1,588 32
City of Worcester,	1,810 76
	$11,820 29

The sums so received prior to March 23, 1907, were annually distributed among the cities and towns of the District, but since that date, in accordance with the provisions of chapter 238 of the Acts of 1907, the sums so received have been paid into the sinking fund.

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works: —

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Administration applicable to all parts of the construction and acquisition of the works,		$5,873 80		$294,326 87
Wachusett Dam and Reservoir: —				
Wachusett Dam,	$10 77		$2,378,206 05	
Power plant,	104,395 64		106,831 70	
Power house floor,	8,168 78		8,168 78	
North Dike,	-		792,264 68	
South Dike,	-		137,075 55	
Removal of soil,	-		2,536,612 66	
Relocation of railroads,	-		881,872 45	
Roads and bridges,	-		547,867 76	
Real estate,	82 85		3,240,271 91	
Damages, real estate not taken, business and loss of wages,	-		532,247 07	
Other expenses,	-		8,547 92	
		112,658 04		11,169,966 53
Improving Wachusett watershed,		4,505 95		235,634 73
Wachusett Aqueduct,		-		1,797,948 85
Sudbury Reservoir,		-		2,923,146 96
Protection of Sudbury supply,		-		129,190 36
Improving Sudbury watershed,		-		95,711 84
Protection of Cochituate supply,		-		9,000 00
Improving Cochituate watershed,		-		8,860 68
Improving Lake Cochituate,		-		104,141 29
Pipe lines, Dam No. 3 to Dam No. 1,		-		48,471 48
Pipe line, Rosemary siphon,		-		23,142 96
Weston Aqueduct: —				
Aqueduct,	-		$2,353,820 11	
Reservoir,	-		289,001 82	
Real estate, taxes and other expenses,	-		206,668 18	
		-		2,849,490 11
Distribution system: —				
Low service: —				
New 48-inch main, Section 31,	-		$162,696 06	
Section 38, Tunnel (East Boston main),	$16,383 39		48,705 66	
Pipe lines and connections,	3,178 73		1,795,163 75	
Pumping station, Chestnut Hill,	-		462,572 19	
Reservoir, Spot Pond,	-		582,198 73	
Gate-house and connections, Chestnut Hill Reservoir,	-		65,480 88	
Real estate and other expenses,	2 80		92,938 97	
Northern high service: —				
Pipe lines and connections,	954 10		528,439 86	
Spot Pond pumping station,	-		291,829 35	
Fells Reservoir, Stoneham,	-		141,392 94	
Bear Hill Reservoir, Stoneham,	-		38,267 70	
Real estate and other expenses,	-		14,838 05	
Amounts carried forward,	$ 20,519 02	$123,037 79	$4,224,516 14	$19,689,032 67

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,	$20,519 02	$123,037 79	$4,224,516 14	$19,689,082 67
Distribution system — *Concluded.*				
Southern high service: —				
Pipe lines and connections,	10,508 43		526,719 49	
Section 39 (Hyde Park connection),	48,759 63		48,759 63	
Pumping station, Chestnut Hill,	60,874 71		368,569 41	
Forbes Hill Reservoir, Quincy,	-		90,003 49	
Waban Hill Reservoir, Newton,	-		61,592 11	
Real estate and other expenses,	-		10,226 36	
Northern extra high service,	100 82		101,898 59	
Southern extra high service: —				
Pipe lines and connections,	70 71		22,881 81	
Hyde Park connection,				
Section 40,	29,953 48		29,953 48	
Section 41,	14,720 54		14,720 54	
Hyde Park Pumping Station,	7,358 54		7,358 54	
Real estate and other expenses,	7,032 78		7,092 95	
Weston Aqueduct supply mains,	70,589 92		1,030,015 50	
Meters and connections,	5,069 66		89,685 35	
Improving Spot Pond Brook,	-		3,991 23	
Glenwood pipe yard,	-		33,100 59	
Chestnut Hill pipe yard,	-		11,311 26	
		275,558 24		6,682,396 47
Stock — pipes, valves, castings, etc., purchased and sent first to storage yards, and later transferred, as needed, to the various parts of the work: —		$398,596 03		
Amount received,	$66,949 74		$2,538,091 71	
Transferred from storage yards to the various sections of the work and included in costs of special works,	79,624 89		2,400,571 70	
				137,520 01
Deduct excess of transfers over amount purchased during year,		12,675 15		
Diversion of water, South Branch of Nashua River,[1]		-		1,363,935 31
Acquisition of existing water works: —				
Reimbursement city of Boston, partially constructed Reservoir,	-		$1,157,921 59	
Boston water works, taken January 1, 1898,	-		12,768,948 80	
Spot Pond taken from Malden, Medford and Melrose,	-		1,240,229 62	
Waban Hill Reservoir purchased from Newton,	-		60,000 00	
Amounts carried forward,	. . .	$385,920 88	$15,227,100 01	$27,872,884 46

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[1] Of the total expenditures from the beginning of the work, the sum of $150,939.89 is for Clinton sewerage system.

CONSTRUCTION AND ACQUISITION OF WORKS.		For the Year ending December 31, 1911.	From Beginning of Work to December 31, 1911.	
Amounts brought forward,		$385,920 88	$15,227,100 01	$27,872,884 46
Acquisition of existing water works — *Concluded.*				
Expenses: —				
Engineering,	$22,617 52			
Conveyancing,	3,862 92			
Legal, expert and court,	46,648 03			
			73,128 47	
			15,300,228 48	
Deduct following, transferred and charged to special works: —				
Reimbursement city of Boston, transferred to Sudbury Reservoir,	$1,157,921 59			
Waban Hill Reservoir transferred to Distribution Department,	60,000 00			
Stock — pipes, engines, etc., included with Boston Water Works and transferred to Distribution Department,	22,340 91			
			$1,240,262 50	
				$14,059,965 98
Total for construction and acquisition of works,		$385,920 88		$41,932,850 44

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1911.	
Administration,		$12,414 85
General supervision,		31,561 29
Taxes and other expenses,		35,909 55
Wachusett Reservoir Department: —		
Superintendence,	$8,234 25	
Reservoir,	5,296 11	
Forestry,	6,449 94	
Protection of supply,	3,669 03	
Buildings and grounds,	5,044 19	
Wachusett Dam,	6,068 44	
Wachusett Aqueduct,	4,868 95	
Clinton sewerage system: —		
Pumping station,	2,894 16	
Sewers, screens and filter-beds,	3,943 59	
Sanitary inspection,	867 43	
Swamp drainage,	2,714 26	
Power plant,	2,399 27	
		52,449 62
Amount carried forward,		$132,335 31

Maintenance and Operation.	For the Year ending December 31, 1911.	
Amount brought forward,	. . .	$132,335 31
Sudbury Department: —		
Superintendence, Framingham office,	$10,121 63	
Ashland Reservoir,	1,249 19	
Hopkinton Reservoir,	1,599 24	
Whitehall Reservoir,	498 80	
Framingham Reservoirs Nos. 1, 2 and 3,	7,015 35	
Sudbury Reservoir,	5,538 34	
Lake Cochituate,	4,608 66	
Marlborough Brook filters,	1,443 63	
Pegan filters,	2,720 15	
Sudbury and Cochituate watersheds,	715 54	
Sanitary inspection,	3,143 51	
Cochituate Aqueduct,	4,047 36	
Sudbury Aqueduct,	6,966 19	
Weston Aqueduct,	4,987 60	
Improving Lake Cochituate,	7,674 58	
		62,329 77
Distribution Department: —		
Superintendence,	$4,506 68	
Arlington pumping station, pumping service,	6,958 61	
Chestnut Hill low-service pumping station, pumping service,	38,235 86	
Chestnut Hill high-service pumping station, pumping service,	33,202 50	
Spot Pond pumping station, pumping service,	12,180 45	
West Roxbury pumping station, pumping service,	6,208 76	
Arlington standpipe,	45 00	
Bear Hill Reservoir,	143 00	
Chestnut Hill Reservoir and grounds,	10,769 82	
Fells Reservoir,	708 54	
Forbes Hill Reservoir,	1,926 19	
Mystic Lake, conduit and pumping station,	1,900 23	
Mystic Reservoir,	915 74	
Waban Hill Reservoir,	298 25	
Weston Reservoir,	2,536 63	
Spot Pond,	7,632 53	
Buildings at Spot Pond,	159 14	
Pipe lines: —		
Low service,	15,568 18	
Northern high service,	3,629 42	
Southern high service,	4,459 18	
Supply pipe lines,	755 01	
Buildings at Chestnut Hill Reservoir,	1,508 13	
Chestnut Hill pipe yard,	1,841 10	
Glenwood pipe yard and buildings,	3,897 55	
Stables,	5,641 32	
Venturi meters,	919 58	
Measurement of water,	1,273 47	
Arlington pumping station, buildings and grounds,	338 51	
		168,154 38
Total for maintaining and operating works,	. . .	$362,819 46

(7) DETAILED FINANCIAL STATEMENT UNDER METROPOLITAN WATER ACT.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1911.

(a) *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1911, and ending December 31, 1911, is $385,920.88, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1911, is $41,932,850.44.

For maintenance and operation the expenditures for the year have been $362,819.46, and from the beginning of the work, $4,587,988.24.

The salaries of the commissioners, and the other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character: —

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.	From Beginning of Work to December 31, 1911.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.		
Administration.		
Commissioners,	$2,333 33	$123,143 58
Secretary and auditor,	750 00	51,342 03
Clerks and stenographers,	1,709 37	64,342 21
Legal services,	-	2,350 00
Traveling,	38 30	3,712 87
Stationery and printing,	452 20	13,700 22
Postage, express and telegrams,	140 00	3,067 17
Furniture and fixtures,	95	4,289 59
Alterations and repairs of buildings,	59	5,791 56
Amounts carried forward,	$5,424 74	$271,738 23

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,	$5,424 74		$271,738 23	
Administration — Concluded.				
Telephone, lighting, heating, water and care of building,	271 93		12,201 27	
Rent and taxes, main office,	146 20		5,767 69	
Miscellaneous expenses,	30 93		4,619 68	
		$5,873 80		$294,326 87
Engineering.				
Chief engineer and department engineers,	$76 92		$207,548 28	
Principal assistant engineers,	2,371 46		163,485 64	
Engineering assistants,	12,592 70		1,058,585 59	
Consulting engineers,	520 00		26,135 07	
Inspectors,	5,275 15		308,746 20	
Architects,	-		36,161 19	
Railroad and street car travel,	172 07		27,751 20	
Wagon hire,	-		45,337 53	
Stationery and printing,	268 04		27,021 12	
Postage, express and telegrams,	1 00		7,731 00	
Engineering and drafting instruments and tools,	224 35		19,533 88	
Engineering and drafting supplies,	85 42		25,104 93	
Books, maps and photographic supplies,	117 39		7,167 32	
Furniture and fixtures,	1 65		14,980 11	
Alterations and repairs of buildings: —				
Main office,	1 79		14,111 09	
Sub-offices,	-		2,939 36	
Telephone, lighting, heating, water and care of buildings: —				
Main office,	815 88		27,270 35	
Sub-offices,	3 00		19,670 82	
Rent and taxes, main office,	438 60		17,071 55	
Rent of sub-offices and other buildings,	-		4,526 74	
Field offices and sheds,	-		1,274 49	
Clinton office building,	-		9,866 87	
Unclassified supplies,	-		8,264 87	
Miscellaneous expenses,	397 50		9,390 25	
		23,362 92		2,089,675 45
Construction.				
Preliminary work (borings, test pits and other investigations): —				
Advertising,	$88 08		$6,749 97	
Labor,	73 48		118,831 80	
Other preliminary work as given in detail in preceding annual report,	-		36,699 09	
		161 56		162,280 86
Contracts, Wachusett Reservoir: —				
Contracts completed and final payments made prior to January 1, 1911,	-		$5,406,738 30	
McBride & Co., Stillwater improvement,	-		23,314 67	
Sundry bills paid under this contract,	-		3,552 11	
Amounts carried forward,	. . .	$29,398 28	$5,433,605 08	$2,546,283 18

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,	. . .	$29,398 28	$5,433,605 08	$2,546,283 18
Construction — Con.				
Contracts, Wachusett Reservoir — *Con.*				
For Power Plant: —				
Builders Iron Foundry, castings,	$1,562 85		$1,562 85	
Builders Iron Foundry, Venturi meters,	3,750 00		3,750 00	
Davis & Farnum Mfg. Co., castings,	1,610 56		1,610 56	
The Fairbanks Co., hydraulic lift valves,	5,108 00		5,108 00	
Florence Iron Works, castings,	2,561 68		2,561 68	
Niles-Bement Pond Co., traveling crane,	2,500 00		2,500 00	
S. Morgan Smith Co., hydraulic turbine,	1,250 00		1,250 00	
Standard Underground Cable Co., cables,	1,378 10		1,378 10	
U. S. Cast Iron Pipe and Foundry Co., castings,	1,340 64		1,340 64	
S. Morgan Smith Co., hydro electric plant,	61,539 62		61,539 62	
		82,601 45		5,516,206 53
Contracts completed, improving Wachusett Watershed,		-		11,893 75
Contracts completed, Wachusett Aqueduct,		-		1,447,208 55
Contracts completed, Sudbury Reservoir,		-		1,545,028 33
Contracts completed, protection Sudbury supply,		-		9,000 00
Contracts completed, improving Lake Cochituate,		-		60,657 45
Contracts completed, protection Cochituate supply,		-		9,000 00
Contracts completed, Rosemary siphon,		-		5,916 96
Contracts completed, pipe line, Dam No. 3 to Dam No. 1,		-		17,240 22
Contracts completed, Clinton sewerage system,		-		66,878 22
Contracts, Weston Aqueduct: —				
Contracts completed and final payments made prior to January 1, 1911,		-		2,376,004 54
Contracts, Distribution System: —				
Contracts completed and final payments made prior to January 1, 1911,	-		$4,981,287 94	
James L. Bryne, laying water pipes Sect. 40, southern extra high service,	$12,292 15		12,292 15	
Builders Iron Foundry, Venturi meters and recorders,	1,474 40		1,474 40	
Chas. M. Callahan, laying water pipes Sect. 35, northern extra high service,	225 92		4,518 30	
The Hodge Boiler Works, 80-inch steel pipes for Weston Aqueduct supply mains,	3,725 57		3,725 57	
Robb Mumford Boiler Co. (Robb Eng. Co., Ltd., Assignee) two boilers for Chestnut Hill low-service pumping station,	10,448 00		10,448 00	
Michael Russo, laying water pipes on Sect. 37, low-service pipe lines,	1,262 92		13,086 10	
Standard Cast Iron Pipe and Foundry Co., special castings,	2,378 84		5,988 45	
Amounts carried forward,	$31,807 80	$111,999 73	$5,032,820 91	$13,611,317 73

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,	$31,807 80	$111,999 73	$5,082,820 91	$18,611,317 73
Construction — Con.				
Contracts, Distribution System — Con.				
B. F. Sturtevant Co., fuel economizer for Chestnut Hill low-service pumping station,	1,740 00		1,740 00	
U. S. Cast Iron Pipe and Foundry Co., special castings,	57,267 67		57,267 67	
Camois & Williams, laying water pipes on Sect. 33, northern high service,	489 29		14,721 27	
Cavanagh Bros., laying water pipes on Sect. 6, Weston Aqueduct supply mains,	3,916 67		40,577 77	
Andrew M. Cusack, laying water pipes on Sect. 41, southern extra high service,	3,755 40		3,755 40	
De Vincenzi & Baruffoldi, laying water pipes on Sect. 36, northern extra high service,	-		3,233 31	
Joseph Hanreddy, laying water pipes on Sect. 7, Weston Aqueduct supply mains,	49,755 75		102,055 94	
Holly Manufacturing Co., pumping engine for Chestnut Hill high-service pumping station,	35,000 00		35,000 00	
Pratt & Cady Co., water valves,	3,603 15		3,603 15	
Michael Russo & Son, for laying water pipes on Sect. 39, southern high service,	13,583 30		13,583 30	
		200,919 03	$5,358,358 72	
Deduct value of pipes, valves, etc., included in above list, transferred to maintenance account December 31, 1900,	-		3,139 77	
				5,355,218 95
Additional work: —				
Labor,	$32,206 03		$828,812 75	
Professional services, medical services, analyses, etc.,	827 75		4,508 74	
Traveling,	67 63		2,815 43	
Rent,	245 00		4,322 22	
Water rates,	-		1,454 77	
Freight and express,	637 60		14,500 17	
Jobbing and repairing,	503 89		10,449 97	
Tools, machinery, appliances and hardware supplies,	5,857 47		90,101 44	
Electrical supplies,	1,759 93		7,323 86	
Castings, ironwork and metals,	4,082 66		91,341 69	
Iron pipe and valves,	4,552 38		80,314 78	
Blasting supplies,	-		1,950 15	
Paint and coating,	872 52		5,471 98	
Fuel, oil and waste,	483 23		12,661 35	
Lumber and field buildings,	1,661 27		91,673 15	
Drain pipe,	321 36		9,557 16	
Brick, cement and stone,	3,794 45		35,292 40	
Sand, gravel and filling,	903 48		8,506 83	
Amounts carried forward,	$58,776 65	$312,918 76	$1,301,058 84	$18,966,536 68

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,	$58,776 65	$312,918 76	$1,301,058 84	$18,966,536 68
Construction — Con.				
Additional work — *Con.*				
Municipal and corporation work,	145 67		220,810 34	
Police service,	-		210,801 74	
Sanitary inspection,	-		13,107 09	
Judgments and settlements for damages,	-		53,124 26	
Unclassified supplies,	1,045 11		19,023 41	
Miscellaneous expenses,	1,398 31		7,552 56	
		61,365 74		1,825,478 24
Legal and expert: —				
Legal services,	-		$4,668 82	
Expert services,	-		1,862 66	
Court expenses,	-		1,317 20	
Miscellaneous expenses,	-		185 80	
		-		8,034 48
Real Estate.				
Legal and expert: —				
Legal services,	-		$4,736 31	
Conveyancer and assistants,	$217 00		110,861 97	
Experts,	-		18,008 93	
Appraisers,	75 00		22,407 75	
Court expenses,	-		11,139 43	
Counsel expenses,	-		43 25	
Conveyancing supplies,	3 00		3,193 53	
Conveyancing expenses,	39 35		6,017 29	
Miscellaneous expenses,	8 00		4,334 15	
Settlements made by Board,	11,294 03		3,439,659 10	
Judgments,	-		170,716 24	
Taxes and tax equivalents,	-		68,182 41	
Care and disposal,	-		86,901 14	
		11,636 38		3,946,201 50
Damages to Real Estate not taken, to Business and on Account of Loss of Wages.				
Legal and expert: —				
Legal services,	-		$1,130 67	
Expert services,	-		2,857 62	
Court expenses,	-		15,394 34	
Miscellaneous expenses,	-		125 00	
Settlements,	-		415,513 65	
Judgments,	-		116,733 42	
		-		551,754 70
Claims on Account of Diversion of Water.				
Legal and expert: —				
Legal services,	-		$3,774 98	
Expert services,	-		19,339 69	
Amounts carried forward,	. . .	$385,920 88	$23,114 67	$25,298,005 60

General Character of Expenditures.	For the Year ending December 31, 1911.	From Beginning of Work to December 31, 1911.	
Amounts brought forward,	$385,920 88	$23,114 67	$25,298,005 60
Claims on Account of Diversion of Water — Con.			
Legal and expert — *Con.*			
Court expenses,	-	20,775 49	
Miscellaneous expenses,	-	1,289 58	
Settlements,	-	917,350 00	
Judgments,	-	220,969 67	
	-		1,183,499 41
Purchase of Existing Water Works.			
Legal and expert: —			
Legal services,	-	$1,878 89	
Expert services,	-	13,569 82	
Court expenses,	-	29,728 38	
Miscellaneous expenses,	-	1,470 94	
Settlements and judgments,	-	15,227,100 01	
	-		15,273,748 04
Relocation Central Massachusetts Railroad.			
Settlements,	-		177,597 39
Total amount of construction expenditures,	$385,920 88		$41,932,850 44

General Character of Expenditures.	For the Year ending December 31, 1911.	
MAINTENANCE AND OPERATION OF WORKS.		
Administration: —		
Commissioners,	$4,666 67	
Secretary and assistants,	5,110 80	
Rent,	542 38	
Repairs of building,	70 52	
Fuel,	42 19	
Lighting,	37 18	
Care of building,	350 37	
Postage,	-	
Printing, stationery and office supplies,	1,454 82	
Telephones,	75 89	
Traveling expenses,	109 68	
Miscellaneous expenses,	70 10	
		$12,530 60
General supervision: —		
Chief engineer and assistants,	$25,611 00	
Rent,	1,627 20	
Amounts carried forward,	$27,238 20	$12,530 60

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.	
Amounts brought forward,	$27,238 20	$12,530 60
MAINTENANCE AND OPERATION OF WORKS — *Con.*		
General supervision — *Con.*		
Repairs of building,	607 59	
Fuel,	126 56	
Lighting,	112 84	
Care of building,	1,051 16	
Postage,	154 00	
Printing, stationery and office supplies,	665 10	
Telephones,	329 18	
Traveling expenses,	521 50	
Miscellaneous expenses,	755 66	
		31,561 29
Pumping service: —		
Labor,	$58,596 44	
Fuel,	33,197 54	
Oil, waste and packing,	1,405 88	
Repairs,	1,590 29	
Small supplies,	1,226 38	
Rent, West Roxbury pumping station,	764 65	
		96,781 18
Reservoirs, aqueducts, pipe lines, buildings and grounds: —		
Superintendents,	$6,784 97	
Engineering assistants,	8,714 77	
Sanitary inspectors,	3,187 66	
Labor, pay roll,	126,194 17	
Labor, miscellaneous,	1,970 21	
Alterations and repairs of pumping stations,	382 43	
Alterations and repairs of other buildings and structures,	1,452 49	
Automobiles,	1,874 70	
Brick,	223 30	
Brooms, brushes and janitor's supplies,	89 13	
Castings, ironwork and metals,	1,419 44	
Cement and lime,	526 40	
Drafting and photo supplies,	172 34	
Fertilizer and planting material,	1,230 17	
Freight and express,	326 27	
Fuel,	2,890 56	
Gypsy moth supplies,	2,044 34	
Hardware,	727 79	
Hay and grain,	1,922 19	
Horses,	262 50	
Lighting,	477 05	
Lumber,	1,860 08	
Machinery,	4 91	
Paints and oils.	945 12	
Amounts carried forward,	$165,682 99	$140,873 07

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.	
Amounts brought forward,	$165,682 99	$140,873 07
MAINTENANCE AND OPERATION OF WORKS — *Con.*		
Reservoirs, aqueducts, pipe lines, buildings and grounds — *Con.*		
Pipe and fittings,	1,463 39	
Postage,	98 14	
Printing, stationery and office supplies,	782 99	
Rubber and oiled goods,	90 15	
Stable expenses,	966 98	
Sand, gravel and stone,	1,021 32	
Traveling expenses,	2,366 14	
Telephones,	928 32	
Teaming,	973 03	
Tools and appliances,	1,390 85	
Vehicles, harnesses and fittings,	814 07	
Municipal and corporation work,	39 43	
Miscellaneous expenses,	2,929 36	
Contracts: —		
Henry Spinach Contracting Co., contract 19-M, improvement of Lake Cochituate (surface-water drains in Framingham, Natick and Wayland),	5,355 43	
Builders Iron Foundry, contract 337-M, for one Venturi meter for Reservoir Department,	1,250 00	
		186,152 59
Payments in lieu of taxes,		35,793 80
Total expenditures for maintenance and operation,		$362,819 46

(*b*) *Receipts.*

The total amount of receipts from the operations of the Board and from sales of property for the year beginning January 1, 1911, and ending December 31, 1911, is $50,511.78, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1911, is $765,484.84. The general character of these receipts is as follows: —

General Character of Receipts.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
For distribution back to District: —				
Fees for admission to District,	-		$92,265 00	
Water furnished to cities and towns outside of District,	-		90,454 77	
Water furnished to water companies,	-		37,145 88	
		-		$219,865 65
To the credit of the loan fund: —				
Real estate and buildings,	$35 00		$44,074 34	
Tools, supplies and reimbursements,	10,247 67		164,782 37	
District entrance fees (Swampscott),	-		90,000 00	
		$10,282 67		298,856 71
To the credit of the maintenance fund: —				
Tools, supplies and reimbursements,	$20,002 87		$46,778 94	
		20,002 87		46,778 94
To the credit of the sinking fund: —				
Water furnished to cities and towns outside of District and to water companies,	$11,820 29		$32,619 04	
Forfeiture for contracts awarded but not executed,	-		500 00	
Rents,	1,624 32		95,697 10	
Land products,	6,675 03		67,601 89	
Unclassified receipts and interest,	106 60		3,565 51	
		20,226 24		199,983 54
Total receipts,		$50,511 78		$765,484 84

The foregoing receipts have been credited to the various objects or works, as follows: —

Sources of Receipts.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Admission into Metropolitan Water District (Quincy, Nahant, Arlington, Stoneham, Milton, Lexington and Swampscott),	-		$182,265 00	
Supplying water to cities and towns outside of Water District (Swampscott, Revere, Lexington, Wakefield, Cambridge, Framingham, Westborough State Hospital, Worcester and U. S. Government), and to water companies (Framingham, Milton and Revere),	$11,820 29		160,219 69	
		$11,820 29		$342,484 69
Amounts carried forward,		$11,820 29		$342,484 69

SOURCES OF RECEIPTS.	For the Year ending December 31,1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,		$11,820 29		$342,484 69
Construction and acquisition of works: —				
Administration,	$58 54		$343 60	
Wachusett Dam,	277 32		7,189 57	
Wachusett Reservoir,	326 94		140,369 11	
Wachusett Aqueduct,	-		5,204 70	
Weston Aqueduct,	-		5,200 13	
Sudbury Reservoir,	-		10,640 42	
Distribution system,	9,656 89		110,997 48	
Diversion of water, Clinton sewerage system,	21 52		1,389 46	
Purchase of existing water works,	-		18,119 08	
		10,341 21		299,453 55
Maintenance and operation of works: —				
Administration,	$125 03		$346 42	
General supervision,	752 25		2,005 01	
Wachusett Aqueduct,	2,065 55		7,039 33	
Wachusett Reservoir,	7,530 54		40,649 21	
Power plant,	7,150 76		7,150 76	
Sudbury system,	2,076 64		19,761 11	
Distribution system,	8,177 24		40,779 70	
Clinton sewerage system,	472 27		5,815 06	
		28,350 28		123,546 60
Total receipts,		$50,511 78		$765,484 84

(*c*) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate and buildings connected therewith.

(*d*) *Liabilities.*

The sums due on monthly pay rolls amount to $1,597.42, and there are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

Name.	Work.	Amount.
McBride & Co., ...	Contract 283, Stillwater improvement, Wachusett Reservoir.	$778 09[1]
Camoia & Williams, . . .	Contract 308, Section 33 of northern high-service pipe lines, Distribution System.	200 00
De Vincenzi & Baruffoldi, . .	Contract 322, Section 36 of northern extra high-service pipe lines, Distribution System.	100 00
Joseph Hanreddy, ...	Contract 314, Section 7 of the Weston Aqueduct supply mains.	9,774 58
Cavanagh Bros., ...	Contract 323, Section 6 of the Weston Aqueduct supply mains.	200 00
Michael Russo & Son, . . .	Contract 341, Section 39 of southern high-service pipe lines, Distribution System.	2,397 05
Holly Manufacturing Company, .	Contract 312, pumping engine for Chestnut Hill low-service pumping station.	14,769 00
Andrew M. Cusack, . . .	Contract 344, Section 41 of the southern extra high-service pipe lines, Distribution System.	662 72
Pratt & Cady Co., ...	Contract 340, water valves for Distribution System.	635 55
S. Morgan Smith Co., . . .	Contract 330, hydro-electric plant at Wachusett Dam in Clinton, Mass.	6,850 00

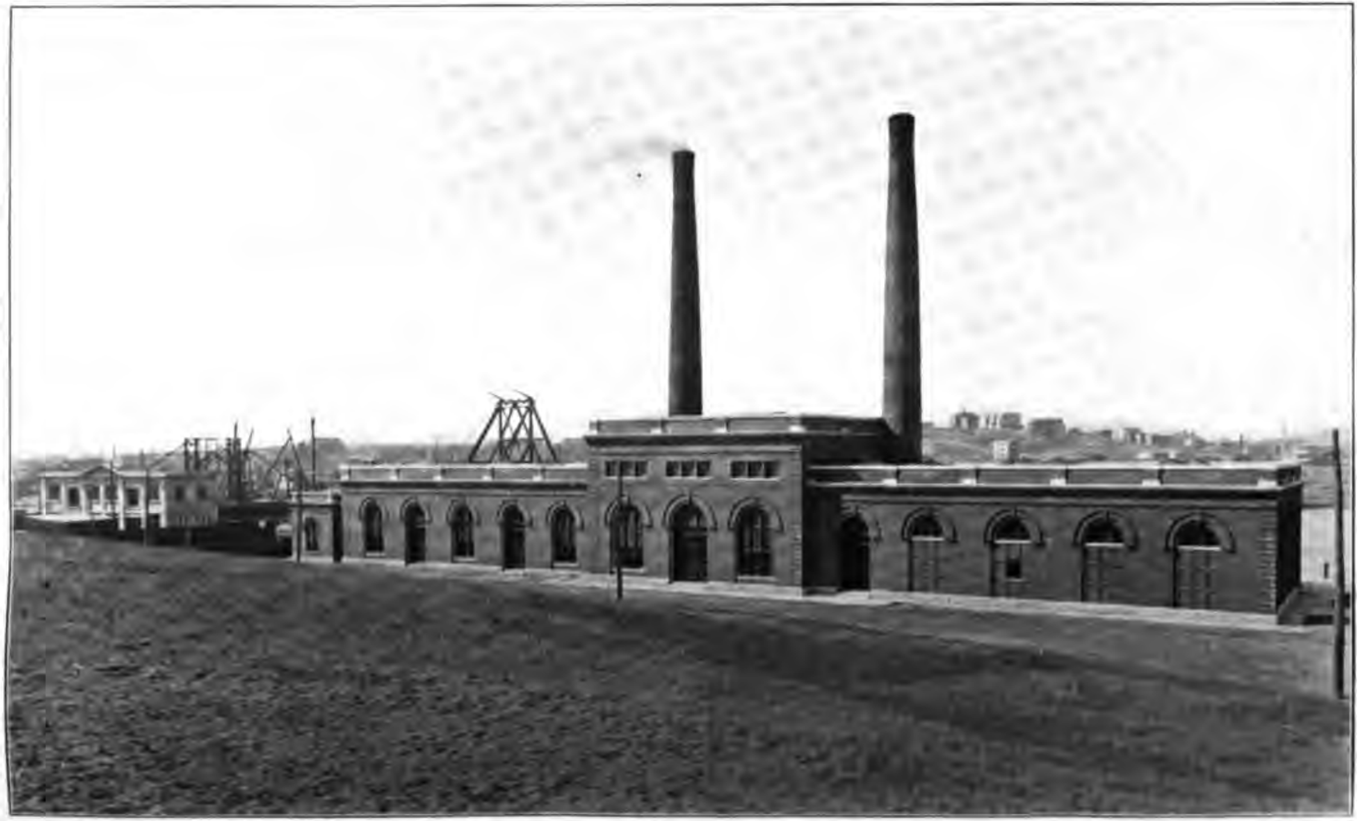
[1] Held pending settlement of claims on account of this contract.

It is impossible to state the amounts due on the claims of the following for land damages, for water rights taken and for damages to established business, as no sums have been agreed upon, and suits are now pending in court for the determination of most of them: —

Patrick Bradley, Henry F. Keyes, James E. Welch, Byron D. Allen, J. Frank Wood *et al.*, Asa Knight, Edward F. Merriam, Sanford C. Kendall, estate of William H. Vickery, James H. and Hannah S. Wood, Francis W. M. Goodale, heirs of Willard Morse, Caroline R. Braman, Charles G. Rice, Nehemiah W. Rice *et al.*, John Ward *et al.*, heirs of George K. Ward, heirs of Francis Pettee, William F. Harbach *et al.*, Royal S. Wentworth *et al.*, trustees.

VI. METROPOLITAN SEWERAGE WORKS.

The North Metropolitan Sewerage District embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Somerville and Woburn, and the towns of Arlington, Belmont, Revere, Stoneham, Wakefield, Winchester and Winthrop, and parts of the city of Boston and the town of Lexington, — comprising in all 9 cities and 8 towns, with an area of 90.50 square miles. The District has an estimated population, based upon the United States Census of 1910, as of December 31, 1911, of 545,870. Of the total population



EAST BOSTON PUMPING STATION AS EXTENDED, WITH NEW STABLE AND LOCKER BUILDING AT LEFT.

it is estimated that 88 per cent., or 480,600 people contribute sewage to the North Metropolitan System. The total cost of the North Metropolitan Sewerage Works has been $6,686,891.50.

The South Metropolitan Sewerage District includes the cities of Newton, Quincy and Waltham, and the towns of Brookline, Milton and Watertown, and parts of the city of Boston (including the former town of Hyde Park) and the town of Dedham, — a total of 4 cities and 4 towns. This district has an area of 100.87 square miles, with an estimated population as of December 31, 1911, of 370,580. According to the estimates made 65.3 per cent. of this population, or 241,865, contribute sewage to the South Metropolitan System. The total expenditures for construction of the South Metropolitan Sewerage Works have amounted to $8,813,232.53.

(1) NORTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

The amount expended for construction on account of the North Metropolitan Sewerage System during the past year was $165,695.35. The works under active construction during the year were the extension of the East Boston pumping station, the erection of a stable and locker building at East Boston, and the Malden and Everett sewer extension.

The work of extending the Deer Island pumping station and installing a new pumping engine with its equipment of boilers and other apparatus was substantially completed in the preceding year, but there was expended on account of the extension, largely in settlement of contracts, the sum of $19,625.38. The total cost of the additions to the building and equipment was $195,373.14.

(*a*) *East Boston Pumping Station Extension.*

The repairs and extensions to the East Boston pumping station which have been in progress were brought so near to completion during the preceding year that the building and wharf have been in entire use and the engine has been in active operation for regular service for the last three months of the past year. The new pumping engine, which has a capacity for pumping 100,000,000 gallons of sewage per day with a vertical lift of 19 feet, received its final test on December 1, 1911. The test was successful and the engine developed a duty slightly in excess of that guaranteed by the contractors.

The sum of $78,913.36 was expended during the past year on account of the appropriation for the extension, and the total expenditures have amounted to $242,438.27. This total included $143,633.55 as the cost of the building extension, $8,801.87 as the cost of the pile wharf, and $90,002.85 as the cost of the pumping engine and apparatus.

Some rearrangement of the screens and screen-house will at least be required. The original plans of the Board contemplated the installation of entirely new screening machinery with the acquisition of some additional land in connection with the work. The present screens are operated disadvantageously under ground, and their operation is difficult and unsanitary as well as expensive and uneconomical.

(*b*) *East Boston Stable and Locker Building.*

A beginning had been made in the preceding year in the erection of a building for stable and locker purposes in East Boston on a lot between Chelsea Street and the Grand Junction Railroad, which separates the lot from the East Boston pumping station. The new building has a length of 65 feet and a width of 28 feet, and is two stories in height. It is built of reinforced concrete and is believed to be fireproof. It has accommodations in the stable for 5 horses, and the locker portion constitutes the chief headquarters for the maintenance and repair forces of the North Metropolitan System. The sum of $4,524.40 was expended for the purchase of the land, and a further sum of $14,166.75 has been expended in the erection and equipment of the building.

(*c*) *Malden and Everett Sewer Extension.*

In accordance with the provisions of chapter 512 of the Acts of 1911, the Board purchased from the city of Malden the main sewer extending in Eastern Avenue from the corner of Bryant Street to Broadway, and constructed a new sewer in Broadway from Eastern Avenue to the boundary line between the city of Malden and the city of Everett. The sewer purchased was about 5,000 feet in length, in part 30 inches in diameter and in part 24 inches; and the new sewer constructed in Broadway extends a distance of 2,632 feet, all an 18-inch pipe sewer except 112 feet which consists of 12-inch pipe. The extension was made particularly for the purpose of providing for the drainage of about 80 acres in the southeasterly portion of Malden and about 80 acres in the northerly section of Everett. Under the act the Board was authorized to pay to the city of Malden the actual cost of its sewer in Eastern Avenue which was taken, amounting to the sum of $36,480.08, and the cost of the sewer constructed has amounted to $21,290.62. Inasmuch as this extension was built for the special benefit of the two cities, it is provided by the act that the Treasurer of the Commonwealth shall, in addition to levying the assessment required by law to meet the interest and sinking fund requirements of the North Metropolitan System, assess annually upon the two cities in equal shares such sums as may be necessary to satisfy the interest and sinking fund requirements of the additional bonds which were issued for carrying out this improvement.

(2) South Metropolitan Sewerage System — Construction.

But little construction was performed during the last year in the South Metropolitan Sewerage System, the amount expended being $20,452.89. Nearly all of this sum was expended upon the Quincy sewage lifting station which had been nearly completed at the close of the preceding year. The building was ready for operation early in the past year and a few houses in the Hough's Neck section have been connected with the local sewer, from which the sewage is lifted so as to be carried into the High-level Sewer. This lifting station is operated by electricity generated at the Nut Island screen-house. It is expected that the city of Quincy will avail itself of the station to a greater extent during the coming year. The amount already expended on account of the station has been $24,044.60.

(3) Acquisition of Land and Settlements.

The Board acquired by taking under the act of the Legislature the main sewer of the city of Malden in Eastern Avenue and a settlement was effected by the payment of the sum of $36,480.08. A taking was also made of the right to construct the sewer in Broadway in the city of Malden.

Takings for Metropolitan Sewerage Works for the Year 1911.

No.	Location and Description.	Former Owner.	Recorded.	Purpose of Taking.
25	Malden, — Existing sewer in Eastern Avenue from Bryant Street to Broadway, a distance of 4,799 feet, and rights to maintain, repair, etc., the same.	City of Malden.	1911. June 19.	Additional outlet for sewage of Malden and Everett, North Metropolitan System.
26	Malden, — Right to construct, maintain, etc., sewer in Broadway, from Eastern Avenue to Everett boundary line, a distance of about 2,654 feet.	Public street.	June 19.	Additional outlet for sewage of Malden and Everett, North Metropolitan System.

(4) North Metropolitan System — Maintenance.

The cost of the maintenance and operation of the North Metropolitan Sewerage Works during the past year was $149,163.19, which included the sum of $865 expended in completing the repairs on the East Boston pumping station under the special appropriation of $40,000.

(a) *Sewers and Pumping Stations.*

The length of the Metropolitan sewers in the North Metropolitan System is now 59.92 miles, and the local sewers connected with the Metropolitan sewers have a length of 683.05 miles, involving 71,860 connections.

The sewage before it is finally disposed of in the harbor off Deer Island is lifted, the most of it at least twice and a portion three times, by pumping at the four stations, the Alewife Brook, Charlestown, East Boston and Deer Island pumping stations.

The daily average amount of sewage discharged into the harbor from the Deer Island outlet was 52,800,000 gallons, which was a daily average for each individual of the population contributing sewage of 109.8 gallons. This daily average is made larger from the fact that a considerable number of the local sewers permit the direct introduction of rain water. The total amount of the discharge is 6,200,000 gallons per day less than that of the preceding year, a decrease which is principally accounted for by the conditions of the rainfall. The maximum amount of sewage discharged in any one day in the year was 103,000,000 gallons.

The pumping stations operated for the North Metropolitan Sewerage System are as follows: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Deer Island Station,	4	235,000,000	19
East Boston Station,	4	235,000,000	19
Charlestown Station,	3	104,000,000	11 8
Alewife Brook Station,	3	22,000,000	13

There were obtained for the operation of the pumping stations 6,900.27 tons of bituminous coal, which was purchased at average prices at the different stations varying from $3.79 to $4.47 per gross ton delivered in the bins.

The sums expended for the labor of engineers and their assistants in the various pumping stations of the district amounted to $58,005.81, and for fuel amounted to $27,133.44. The total expenditure for the operation of the stations was $95,568.09.

The average cost per million gallons of sewage lifted per foot at the several stations was $0.135.

(*b*) *Siphons.*

The siphon introduced in the Metropolitan sewer in Cambridge by the building of the subway of the Boston Elevated Railway Company, and the siphon called for in the sewer crossing the Alewife Brook in Arlington in order to conform to the improvements made by the Metropolitan Park Commission, have required constant cleaning and flushing, and a gang of 5 men has been regularly employed for a portion of the week for this purpose. Their labor has added $1050 to the cost of the maintenance of the North Metropolitan System.

(*c*) *Tanneries and Gelatine and Glue Works.*

The oversight and care of the Metropolitan sewers, which receive the sewage and waste material discharged from the tanneries and other manufactories in Winchester, Woburn and Stoneham, have involved the employment of a special force consisting of a foreman and 5 men. Constant cleaning and flushing are required in order that the sewers shall not be clogged, and the settling tanks which have been introduced at the various establishments, in which the most objectionable matter is deposited before the contents are allowed to enter the sewers, call for continuous inspection. The semi-liquid sludge removed from the tanks for disposal amounted in the year to about 6,500 cubic yards. The cost attending this work is so great as to make the present situation a serious burden to the North Metropolitan Sewerage District.

(5) SOUTH METROPOLITAN SYSTEM — MAINTENANCE.

The entire cost of maintenance during the past year has been $100,399.39.

Sewers and Pumping Stations.

The Metropolitan sewers in the South Metropolitan System have a length of 43.42 miles, and with these are connected local sewers having a length of 557.52 miles, involving 34,415 connections.

The pumping stations operated for the South Metropolitan Sewerage System are as follows: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Ward Street Station,	2	100,000,000	45
Quincy Station,	3	18,000,000	28
Quincy Sewage Lifting Station,	2	3,000,000	20

The larger part of the sewage of the District is lifted into the High-level Sewer at the Ward Street pumping station in Roxbury, but the sewage of the city of Quincy is pumped into the sewer at Greenleaf street near the Quincy pumping station. The entire sewage is screened at the Nut Island screen-house for the purpose of intercepting solid matter and is thence discharged at the bottom of the harbor about a mile off from the Island.

The average daily amount of the sewage thus discharged was 42,000,000 gallons, and the largest discharge in a single day was 137,500,000 gallons. The increase in the daily average from last year was 2,400,000 gallons.

The daily average discharge of sewage for each individual contributing sewage in the District was 173.6 gallons.

There were 2,799.65 gross tons of bituminous coal obtained at the two pumping stations and screen-house, which was purchased at average prices varying from $4.09 to $4.47 per gross ton delivered in the bins.

The expenditures for the labor of the engineers and their assistants at the three stations amounted to $33,968.07, and the expenditures for fuel amounted to $11,511.33. The total amount expended for the operation of the stations was $51,563.05.

VII. SEWERAGE WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the fiscal year of the Commonwealth ending with the thirtieth day of November, 1911, was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906, and a copy of this financial abstract is in part printed as Appendix No. 5.

The following statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1911 is herewith presented, in accordance with the provisions of the Act of 1906, as a part of the annual report of the Board.

The Metropolitan Sewerage Loans authorized for the construction of the Sewerage Works of the North Metropolitan System have amounted to $6,635,865.73, to which are added receipts from various sources amounting to $64,560.64. The amount of expenditures approved by the Board for payment for the year 1911 was $165,695.35, and the total amount of expenditures approved to January 1, 1912, was $6,686,891.50. The balance remaining on January 1, 1912, was $13,534.87.

The loans authorized for the construction of the various parts of the South Metropolitan System have amounted to $8,867,046.27. The receipts applicable to the loan fund have been $13,632.51. The amount of expenditures approved for payment in the year 1911 was $20,452.89. The total amount of expenditures approved for payment from the beginning of the works has been $8,813,232.53. The balance remaining for the South Metropolitan System on January 1, 1912, was $67,446.25.

The bonds issued on account of the loans have been for varying periods, not exceeding forty years, and bear interest at the rate of 3 per cent. and 3½ per cent. The premiums received on account of the sale of bonds for the North Metropolitan System have amounted to $179,547.35, and those received on account of the South Metropolitan System have amounted to $410,132.03.

The increase in the debt during the calendar year, as represented by the Metropolitan Sewerage Loans, was $62,000.00. The increase of the sinking fund for the payment of the debt at maturity was, during the same period, $252,933.09. There has consequently been a decrease in the net debt during the calendar year amounting to $190,933.09.

The amount expended for maintenance of the North Metropolitan System in the year 1911 was $149,163.19, and for the South Metropolitan System $100,399.39, a total for both systems of $249,562.58.

The assessments made to meet interest, sinking fund requirements and maintenance and operation of the North Metropolitan System amounted in the year 1911 to $463,311.33, and the assessments for the South Metropolitan System amounted to $468,169.21.

The following is a detailed financial statement regarding the Metropolitan Sewerage Works: —

(1) METROPOLITAN SEWERAGE LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, the expenditures for construction, and the balance available on January 1, 1912, have been as follows: —

(a) *North Metropolitan System.*

Loans authorized under various acts prior to 1911 for the construction of the North Metropolitan System and the various extensions,	$6,573,865 73	
Loan authorized under chapter 512 of the Acts of 1911, for the Malden and Everett extension, ...	62,000 00	
		$6,635,865 73

Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System: —		
For the year ending December 31, 1911, .	$1,168 86	
For the period prior to January 1, 1911, .	63,391 78	
		64,560 64
		$6,700,426 37
Amount approved for payment by the Board[1] out of the Metropolitan Sewerage Loan Fund, North System: —		
For the year ending December 31, 1911, .	$165,695 35	
For the period prior to January 1, 1911, .	6,521,196 15	
		6,686,891 50
Balance, North Metropolitan System, January 1, 1912, .		$13,534 87

(b) *South Metropolitan System.*

Loans authorized under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extension constituting the South Metropolitan System, ...			$8,867,046 27
Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: —			
For the year ending December 31, 1911, .		$231 38	
For the period prior to January 1, 1911, .		13,401 13	
			13,632 51
			$8,880,678 78
Amount approved by the Board[1] for payment out of the Metropolitan Sewerage Loan Fund, South System: —			
On account of the Charles River valley sewer, ...		$800,046 27	
On account of the Neponset valley sewer,		911,531 46	
On account of the High-level sewer and extension: —			
For the year ending December 31, 1911, .	$20,452 89		
For the period prior to January 1, 1911, .	7,081,201 91		
		7,101,654 80	
			8,813,232 53
Balance, South Metropolitan System, January 1, 1912, .			$67,446 25

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[1] The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

(2) ISSUES OF METROPOLITAN SEWERAGE LOAN BONDS.

The Treasurer of the Commonwealth, under the authority of the successive statutes, has from time to time issued bonds designated "Metropolitan Sewerage Loan," amounting for the North System to $6,625,000 and for the South System to $8,877,912. The list of the bonds issued prior to the year 1910 is contained in the Ninth Annual Report. The bonds issued in the year 1911 are as follows: —

DATE OF SALE.	Amount of Bonds sold.	Rate of Interest (Per Cent.).	Price received.	Date due.	Premium.
July 20, 1911, ...	$62,000	3½	100.00[1]	Jan., 1941	-

[1] Not issued or delivered until 1912.

(3) METROPOLITAN SEWERAGE LOANS SINKING FUND.

Under the authority of chapter 122 of the Acts of the year 1899 the Treasurer and Receiver-General of the Commonwealth was required to consolidate the sinking funds of all the Metropolitan Sewerage Loans into one fund, to be known as the Metropolitan Sewerage Loans Sinking Fund.

The Board received during the year, from rentals and from other sources, to be applied to the sinking fund, $259.20.

The sinking fund established has amounted at the end of each year to sums as follows: —

December 31, 1899, .	$361,416 59	December 31, 1906, .	$1,146,998 68
December 31, 1900, .	454,520 57	December 31, 1907, .	1,306,850 30
December 31, 1901, .	545,668 26	December 31, 1908, .	1,492,418 98
December 31, 1902, .	636,084 04	December 31, 1909, .	1,673,784 40
December 31, 1903, .	754,690 41	December 31, 1910, .	1,931,741 89
December 31, 1904, .	878,557 12	December 31, 1911, .	2,184,674 98
December 31, 1905, .	1,008,724 95		

(4) ANNUAL APPROPRIATIONS, RECEIPTS AND EXPENDITURES.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1911, have been as follows: —

North Metropolitan System.

Appropriation under chapter 691 of the Acts of 1911, . .	$152,800 00
Balance of appropriation under chapter 582 of the Acts of 1908, ...	849 43
Receipts from pumping and from other sources, . . .	357 43
	$154,006 86
Amount approved by the Board for payment, ...	149,163 19
Balance, January 1, 1912, ...	$4,843 67

South Metropolitan System.

Appropriation under chapter 687 of the Acts of 1911, . .	$101,800 00
Receipts from pumping and from other sources, . . .	378 46
	$102,178 46
Amount approved by the Board for payment, ...	100,399 39
Balance, January 1, 1912, ...	$1,779 07

(5) ANNUAL ASSESSMENTS.

Assessments for the year, amounting to $463,311.33 for the North Metropolitan System and to $468,169.21 for the South Metropolitan System, were required for the payment of interest and sinking fund requirements and the cost of maintenance and operation of works. The requirements for the North Metropolitan System were: for interest, $202,078.43; for the sinking fund, $111,095.21; and for maintenance, $150,137.69. For the South Metropolitan System the requirements were: for interest, $299,330.62; for the sinking fund, $67,997.19; and for maintenance, $100,841.40. The assessments for both the North and South Metropolitan Systems were made upon the cities and towns in the District in accordance with chapter 369 of the Acts of the year 1906. The respective assessments were as follows: —

North Metropolitan Sewerage System.

Arlington,	$10,948 34	Revere,	$15,308 99
Belmont,	6,007 21	Somerville,	64,250 86
Boston,	77,610 33	Stoneham,	5,346 50
Cambridge,	103,511 80	Wakefield,	9,505 15
Chelsea,	25,718 84	Winchester,	11,566 58
Everett,	27,209 17	Winthrop,	10,773 33
Lexington,	4,210 15	Woburn,	11,883 88
Malden,	41,700 23		
Medford,	22,263 45	Total,	$463,311 33
Melrose,	15,496 52		

South Metropolitan Sewerage System.

Boston,	$202,379 19	Quincy,	$29,264 37
Brookline,	84,798 49	Waltham,	26,560 46
Dedham,	11,571 71	Watertown,	13,749 10
Hyde Park,	14,211 55		
Milton,	21,757 47	Total,	$468,169 21
Newton,	63,876 87		

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works: —

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1911.	From Beginning of Work to December 31, 1911.	
North Metropolitan System.			
Original system, main line and branches,	-		$5,383,957 67
Lexington branch,	-		68,585 15
Everett branch,	-		54,877 12
Wakefield branch,	-		35,698 29
Stoneham branch,	-		11,574 10
Revere extension,	-		215,722 79
Chelsea and Everett outlets,	-		71,216 41
Wakefield branch extension,	-		190,081 97
Belmont extension,	-		57,363 06
Malden extension,	-		67,092 63
Bulkhead, Chelsea creek,	-		3,231 00
North System, enlargement: —			
Administration,	$4,300 28	$13,218 05	
Deer Island pumping station, extensions and additions,	19,625 38	195,373 14	
Amounts carried forward,	$23,925 66	$208,591 19	$6,159,400 19

Construction and Acquisition of Works.	For the Year ending December 31, 1911.		From Beginning of Work to December 31, 1911.	
Amounts brought forward,	$23,925 66		$208,591 19	$6,159,400 19
North Metropolitan System — Con.				
North System, enlargement — *Con.*				
East Boston pumping station, extensions and additions,	78,913 36		242,438 27	
Malden-Everett extension, Sections 65 and 66,	57,138 50		57,770 70	
Stable and locker, East Boston,	5,717 83		18,691 15	
		$165,695 35		527,491 31
Total for North Metropolitan System,		$165,695 35		$6,686,891 50
South Metropolitan System.				
Charles River valley sewer, main line,	-			$800,046 27
Neponset River valley sewer: —				
Main line,	-		$866,595 66	
Brookline branch,	-		44,935 80	
				911,531 46
High-level Sewer,		$285 00		5,992,660 01
High-level Sewer extension: —				
Charles River valley studies,	-		$3,893 71	
Administration,	$1,391 67		16,455 81	
Section 80, day work, West Roxbury and Brookline,	242 50		295,216 41	
Section 81, Brookline,	155 00		129,519 35	
Section 82, Brookline,	-		136,152 02	
Section 82, day work, Park street crossing,	-		2,030 18	
Section 83, Brookline,	247 00		94,065 87	
Section 84, Brookline and Brighton,	-		47,592 89	
Section 85, Brighton,	3 00		227,378 50	
Section 85, day work, Brighton,	-		66,611 62	
Section 86, Brighton,	675 00		57,864 88	
Quincy sewage lifting station,	17,403 72		24,044 60	
Land takings, purchase and recording,	50 00		8,168 95	
		20,167 89		1,108,994 79
Total for South Metropolitan System,		$20,452 89		$8,813,232 53
Total for construction for both systems,		$186,148 24		$15,500,124 03

Maintenance.	For the Year ending December 31, 1911.	From Beginning of Work to December 31, 1911.
North Metropolitan System,	$149,163 19	$1,885,736 29
South Metropolitan System,	100,399 39	1,511,466 37
Total for maintenance, both systems,	$249,562 58	$3,397,202 66

(7) DETAILED FINANCIAL STATEMENT.

The Board herewith presents, in accordance with the Metropolitan Sewerage Acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1911: —

(a) *Expenditures and Disbursements.*

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.	
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.		
North Metropolitan System.		
Administration: —		
Commissioners,	$1,166 67	
Secretary,	750 00	
Clerks and stenographers,	1,551 01	
Traveling,	-	
Stationery, printing and office supplies,	505 23	
Telephone, lighting, heating, water and care of building,	162 11	
Rent and taxes, main office,	165 26	
Repairs of building,	-	
Miscellaneous expenses,	-	
		$4,300 28
Engineering: —		
Chief engineer,	$833 33	
Engineering assistants,	3,648 50	
Inspectors,	1,375 00	
Traveling expenses,	25 25	
Stationery, printing and office supplies,	20 89	
Engineering and drafting instruments and tools,	-	
Engineering and drafting supplies,	-	
Telephone, lighting, heating, water and care of building,	486 37	
Rent and taxes,	495 80	
Repairs of building,	-	
Miscellaneous expenses,	5 24	
		6,890 38
Advertising,	-	
Labor and teaming,	$12,818 79	
Tools, machinery and appliances,	7,016 64	
Brick, cement, lumber and other field supplies and expenses,	7,233 35	
		27,068 78
Contracts: —		
Allis-Chalmers Co., contract 68, addition to pumping plant at Deer Island pumping station,	$17,307 50	
Allis-Chalmers Co., contract 73, addition to pumping plant at East Boston pumping station,	33,300 00	
Amounts carried forward,	$50,607 50	$38,259 44

General Character of Expenditures.	For the Year ending December 31, 1911.	
Amounts brought forward,	$50,607 50	$38,259 44
North Metropolitan System — Con.		
Contracts — *Con.*		
The Philip Carey Co., contract 93, magnesia covering to boilers and piping at East Boston pumping station,	2,234 55	
Lumsden & Van Stone Co., contract 89, piping in East Boston pumping station,	5,400 00	
Robb-Mumford Boiler Co. (Robb Engineering Co., Ltd., assignee), contract 78, furnishing and erecting six vertical fire-tube boilers with smoke flue and galleries, at the East Boston pumping station,	6,386 60	
A. G. Tomasello, contract 81, constructing Section 66 of the North Metropolitan Sewerage System (Malden-Everett Extension),	17,553 74	
Woodbury & Leighton Co., contract 74, extension of engine, boiler, screen-house and coal-house at East Boston pumping station,	8,764 87[1]	
		90,947 26
Real estate: —		
Settlements,	$36,480 08	
Legal, conveyancing and expert,	8 57	
		36,488 65
Total for North Metropolitan System,	. . .	$165,695 35
South Metropolitan System.		
High-level Sewer.		
Engineering: —		
Engineers, inspectors, rodmen, laborers and others,	$285 00	
		$285 00
High-level Sewer Extension.		
Administration: —		
Commissioners,	$750 00	
Secretary,	-	
Clerks and stenographers,	396 67	
Traveling,	-	
Stationery, printing and office supplies,	127 01	
Telephone, lighting, heating, water and care of building,	61 65	
Rent and taxes, main office,	55 09	
Miscellaneous expenses,	1 25	
		1,391 67
Engineering: —		
Chief engineer,	-	
Engineering assistants,	$2,829 43	
Amounts carried forward,	$2,829 43	$1,676 67

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[1] Of this amount $15.57 was paid to the North Metropolitan Maintenance Fund, to balance an overpayment from said fund on account of special appropriation Chapter 582, Acts of 1908, there being but $849.43 to cover the final estimate amounting to $865 due Woodbury & Leighton under Contract 74A.

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.	
Amounts brought forward,	$2,829 43	$1,676 67
South Metropolitan System — Con.		
Engineering — *Con.*		
Inspectors,	-	
Traveling expenses,	-	
Stationery, printing and office supplies,	2 29	
Engineering and drafting instruments and tools,	-	
Engineering and drafting supplies,	-	
Telephone, lighting, heating, water and care of building,	184 94	
Rent and taxes,	165 26	
Miscellaneous expenses,	-	
		3,181 92
Advertising,	-	
Labor and teaming,	$3,151 37	
Tools, machinery and appliances,	1,375 78	
Brick, cement, lumber and other field supplies and expenses,	2,736 19	
		7,263 34
Contracts: —		
John Cashman & Sons Co., contract 87, Quincy sewage lifting station, foundations,	$6,555 96	
C. A. Dodge Co., contract 88, Quincy sewage lifting station, superstructure,	1,725 00	
		8,280 96
Real estate: —		
Settlements,	-	
Legal, conveyancing and expert,	$50 00	
		50 00
Total for South Metropolitan System,		$20,452 89
MAINTENANCE AND OPERATION OF WORKS.		
North Metropolitan System.		
Administration: —		
Commissioners,	$2,749 99	
Secretary and assistants,	2,432 89	
Rent,	247 88	
Heating, lighting and care of building,	233 57	
Repairs of building,	19 02	
Postage,	41 00	
Printing, stationery and office supplies,	647 80	
Telephones,	60 14	
Traveling expenses,	37 69	
Miscellaneous expenses,	25 00	
		$6,494 98
General supervision: —		
Chief engineer and assistants,	$8,203 15	
Rent,	743 69	
Heating, lighting and care of building,	700 80	
Amounts carried forward,	$9,647 64	$6,494 98

General Character of Expenditures.	For the Year ending December 31, 1911.	
Amounts brought forward,	$9,647 64	$6,494 98
North Metropolitan System — Con.		
General supervision — *Con.*		
Repairs of building,	56 98	
Postage,	60 00	
Printing, stationery and office supplies,	288 93	
Telephones,	180 44	
Traveling expenses,	145 00	
Miscellaneous expenses,	17 32	
		10,396 31
Deer Island pumping station: —		
Labor,	$15,745 75	
Fuel,	9,204 34	
Oil and waste,	657 60	
Water,	874 80	
Packing,	250 75	
Repairs and renewals,	466 84	
Telephones,	190 81	
General supplies,	847 04	
Miscellaneous supplies and expenses,	103 70	
		28,341 63
East Boston pumping station: —		
Labor,	$19,718 80	
Fuel,	13,378 03	
Oil and waste,	433 65	
Water,	1,215 60	
Packing,	117 93	
Repairs and renewals,	333 99	
Telephones,	119 34	
General supplies,	1,031 92	
Miscellaneous supplies and expenses,	666 81	
		37,016 07
Charlestown pumping station: —		
Labor,	$14,725 26	
Fuel,	3,259 39	
Oil and waste,	280 27	
Water,	847 20	
Packing,	70 30	
Repairs and renewals,	350 44	
Telephones,	46 49	
General supplies,	457 47	
Miscellaneous supplies and expenses,	123 19	
		20,160 01
Alewife Brook pumping station: —		
Labor,	$7,816 00	
Fuel,	1,291 68	
Oil and waste,	189 88	
Water,	295 80	
Amounts carried forward,	$9,593 36	$102,409 00

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.	
Amounts brought forward,	$9,593 36	$102,409 00
North Metropolitan System — Con.		
Alewife Brook pumping station — *Con.*		
Packing,	15 11	
Repairs and renewals,	138 77	
Telephones,	40 94	
General supplies,	66 76	
Miscellaneous supplies and expenses,	195 44	
		10,050 38
Sewer lines, buildings and grounds: —		
Engineering assistants,	$2,650 00	
Labor,	24,346 99	
Automobiles,	211 21	
Brick, cement and lime,	484 41	
Castings, ironwork and metals,	326 06	
Freight, express and teaming,	1 40	
Fuel and lighting,	64 98	
Jobbing and repairing,	257 51	
Lumber,	107 86	
Machinery, tools and appliances,	656 16	
Paints and oils,	798 91	
Rubber and oiled goods,	342 08	
Sand, gravel and stone,	1 50	
Telephones,	13 85	
Traveling expenses,	342 81	
General supplies,	574 50	
Miscellaneous expenses,	124 69	
		31,304 92
Horses, vehicles and stable account,	$4,533 89	
Renewal East Boston pumping station account Chelsea fire, April 12, 1908: —		
Supplies and expenses,	865 00	
		5,398 89
Total for North Metropolitan System,		$149,163 19
South Metropolitan System.		
Administration: —		
Commissioners,	$2,333 34	
Secretary and assistants,	2,345 81	
Rent,	220 34	
Heating, lighting, and care of building,	206 58	
Repairs of building,	10 43	
Postage,	80 00	
Printing, stationery and office supplies,	525 19	
Telephones,	46 37	
Traveling expenses,	14 00	
Miscellaneous expenses,	26 00	
		$5,808 06
Amount carried forward,		$5,808 06

General Character of Expenditures.	For the Year ending December 31, 1911.	
Amount brought forward,	. . .	$5,808 06
South Metropolitan System — Con.		
General supervision: —		
Chief engineer and assistants,	$5,341 61	
Rent,	661 06	
Heating, lighting and care of building,	619 78	
Repairs of building,	31 29	
Postage,	-	
Printing, stationery and office supplies,	210 19	
Telephones,	139 13	
Traveling expenses,	159 00	
Miscellaneous expenses,	1 00	
		7,163 06
Ward Street pumping station: —		
Labor,	$19,139 74	
Fuel,	7,466 23	
Oil and waste,	309 25	
Water,	1,348 80	
Packing,	108 35	
Repairs and renewals,	820 70	
Telephones,	94 78	
General supplies,	976 34	
Miscellaneous supplies and expenses,	439 92	
		30,704 11
Quincy pumping station: —		
Labor,	$6,946 83	
Fuel,	1,620 85	
Oil and waste,	76 79	
Water,	339 73	
Packing,	11 86	
Repairs and renewals,	128 12	
Telephones,	36 06	
General supplies,	103 94	
Miscellaneous supplies and expenses,	233 61	
		9,497 79
Nut Island screen-house: —		
Labor,	$7,881 50	
Fuel,	2,424 25	
Oil and waste,	52 18	
Water,	356 76	
Packing,	19 10	
Repairs and renewals,	10 40	
Telephones,	55 74	
General supplies,	489 54	
Miscellaneous supplies and expenses,	71 68	
		11,361 15
Amount carried forward,	. . .	$64,534 17

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1911.	
Amount brought forward,		$64,534 17
South Metropolitan System — Con.		
Sewer lines, buildings and grounds: —		
Engineering assistants,	$2,650 00	
Labor,	19,749 38	
Automobiles,	437 64	
Brick, cement and lime,	440 38	
Castings, ironwork and metals,	131 65	
Freight, express and teaming,	–	
Fuel and lighting,	102 80	
Jobbing and repairing,	21 00	
Lumber,	340 84	
Machinery, tools and appliances,	127 77	
Paints and oils,	218 55	
Rubber and oiled goods,	74 62	
Sand, gravel and stone,	45 49	
Telephones,	35 40	
Traveling expenses,	615 68	
General supplies,	224 83	
Miscellaneous expenses,	24 27	
		25,240 30
City of Boston, for pumping and interest,		7,700 00
Horses, vehicles and stable account,		2,924 92
Total for South Metropolitan System,		$100,399 39

(*b*) *Receipts.*

The receipts from the sales of property, from rents and from other sources, have been credited as follows: —

ACCOUNT.	For the Year ending December 31, 1911.	From Beginning of Work to December 31, 1911.
North Metropolitan System — construction,	$1,168 86	$64,560 64
South Metropolitan System — construction,	231 38	13,632 51
North Metropolitan System — maintenance,	357 43	14,998 66
South Metropolitan System — maintenance,	378 46	2,108 66
Metropolitan Sewerage Loans Sinking Fund,	259 20	1,802 59
Totals,	$2,395 33	$97,103 06

(*c*) *Assets.*

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate connected therewith.

(*d*) *Liabilities.*

The sums due on monthly pay rolls amount to $650.72 and there are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
High-level Sewer: —		
National Contracting Co., . .	Sect. 73, contract abandoned, ...	$5,516 17[1]
E. W. Everson & Co., . . .	Sect. 75, contract 14, ...	1,000 00
High-level Sewer Extension: —		
Timothy J. O'Connell, . . .	Sect. 82, in part, contract 57, ...	60 00
Geo. M. Bryne Co., ...	Sect. 85, in part, contract 63, ...	2,508 51
North Metropolitan Construction: —		
Allis-Chalmers Co., ...	Addition to pumping plant at East Boston pumping station, contract 73, ...	3,700 00
A. G. Tomasello, ...	Sect. 66, Malden-Everett extension, contract 81, .	2,969 95

[1] Damages claimed by the Commonwealth on account of the abandonment of the contract exceed this amount.

Claims have been made by the following parties, but it is impossible to state the amounts due for land and other damages, as no sums have been agreed upon, and suits are now pending in the courts for the determination of most of them: —

Anna L. Dunican, Carrie S. Urquhart, N. Jefferson Urquhart, Edwin N. Urquhart, Richard Jones, James Doherty, Michael Niland, William H. Gibbons, Francis Normile, George A. Goddard.

VIII. RAINFALL AND WATER SUPPLY.

The past year has added another to a remarkable series of years of small rainfall. The total rainfall during the year was about 38.5 inches, or about 7 inches below that of a long period of years in the past. Though there was a slight increase in the amount of rainfall over that of the preceding and two or three previous years, owing to the conditions under which the rain fell, a smaller quantity was gained for consumption. The amount of water collected from the various watersheds from which the water is drawn for the supply of the Metropolitan District was less than that recorded in any previous year in which measurements have been taken.

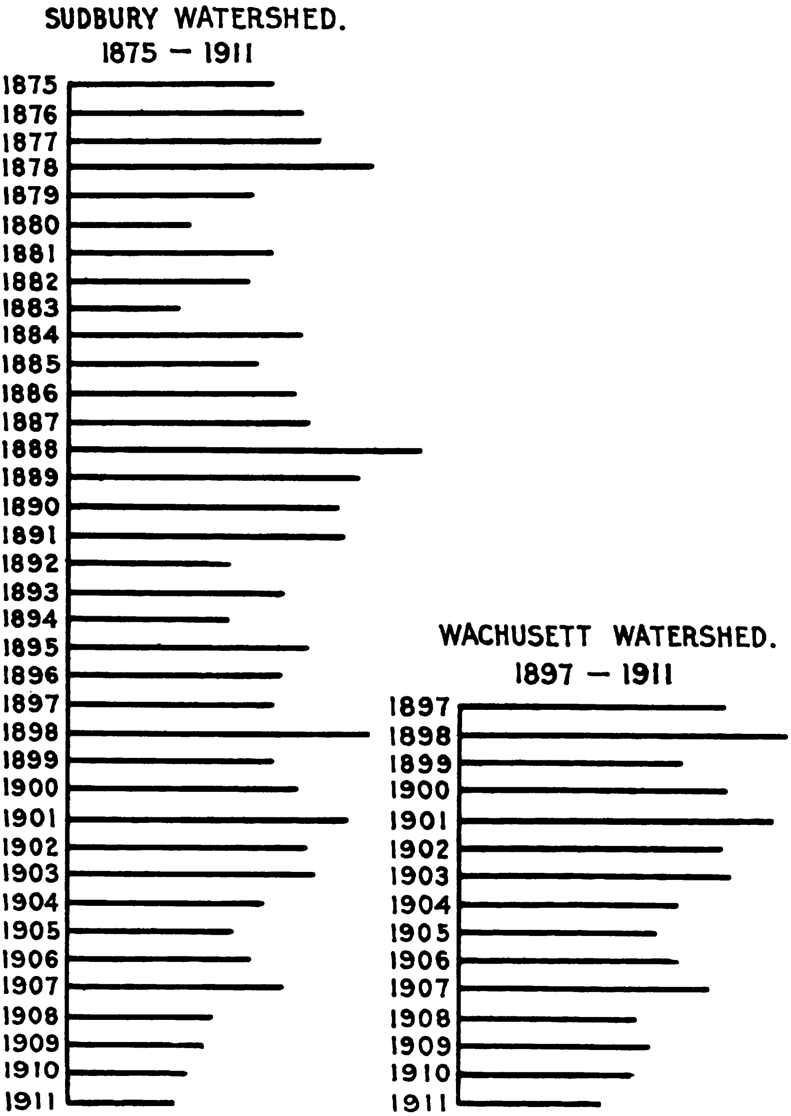
The Wachusett watershed yielded for consumption a daily average per square mile of 682,000 gallons, while the average for the 15 years during which the measurements have been made has been 1,107,000 gallons; and the Sudbury watershed yielded a daily average of 514,000 gallons per square mile as against a daily average of 1,013,000 gallons per square mile during the 37 years for which records have been kept. It is thus shown that the yield in the past year of the two watersheds was respectively 61.6 and 50.7 per cent. of the average amount yielded in the series of years.

The small quantity of water collected for the water supply during the year 1911 is indicated by the accompanying diagram in comparison with the larger quantity collected in each of the previous years. The diagram also illustrates the recurrence during the last four years of a dry period similar to, but still more severe than that of the four years ending with 1883, which has hitherto been looked upon as a period of minimum water supply unprecedented in the records.

IX. CONSUMPTION OF WATER.

For the third consecutive year there has been a reduction in the quantity of water required for the consumption of the Metropolitan District. The maximum quantity of water supplied to the District was reached in the year 1908, when the daily average consumption was 125,441,000 gallons, or 129 gallons for each person. The daily average consumption per capita fell in 1909 to 119 gallons, in 1910 to 110 gallons, and in the past year it was still farther reduced to 105 gallons, or a total consumption of 109,994,800 gallons per day. There is a slight difference between the quantities delivered to the various cities and towns, as measured by the Venturi meters, and the total quantity indicated as delivered to the District by the computation of the amount pumped at the several pumping stations and of the amount flowing in the Weston Aqueduct, on account of the small amount supplied to the stations and outside the

COMPARATIVE AMOUNTS OF WATER COLLECTED IN THE DIFFERENT YEARS ON THE SUDBURY AND WACHUSETT WATERSHEDS PER SQUARE MILE OF WATERSHED.



District and that lost by leakage from the distributing reservoirs and pipe mains.

In 11 of the municipalities there was a decrease in the daily per capita consumption. The largest decrease was in the city of Medford and in the town of Stoneham, where the reduction per capita was respectively 11 and 13. The city of Boston reduced its daily consumption from 130 to 124 gallons per person, and this reduction accounts chiefly for the gratifying decrease of the total consumption of the District.

There were 5 municipalities in which there was an increase in the per capita consumption, Belmont showing an increase of 12 gallons, Nahant of 7 gallons, Revere of 4 gallons, and Malden and Arlington of a single gallon each. Milton and Swampscott maintained the same rate as in the preceding year.

During the past year 14,099 water services, new and old, in the District were equipped with meters, and there was a substantial compliance with the Meter Act of the year 1907 both in the installation of meters on all new services and the equipment with meters of at least five per cent. of all the old services. The cities of Medford and Melrose and the towns of Watertown, Milton, Winthrop, Belmont and Swampscott have now meters upon all their services, and the cities of Malden and Chelsea have metered about 94 per cent. of all services. The city of Boston installed an increased number of meters during the past year, but its percentage of the number of its services metered (27.33) is still the lowest in the list. The cities of Quincy and Chelsea were especially active in the metering of old services.

The weather conditions of the past and the preceding year were similar and in general favorable to a low consumption of water, but the increasing introduction of meters must be considered as the principal factor in the reduction of consumption.

It is, however, apparent more than ever that there is a great waste of water in the Metropolitan District which the increasing use of meters does not prevent. Notwithstanding the large actual decrease in the total quantity of water which is supplied, the amount which is drawn from the pipes between the hours of 1 and 4 in the morning has not decreased; the amount thus drawn between these hours, when the necessary use is comparatively small, has been at the rate of more than 68 gallons per day for each inhabitant of the District. There is a constant leakage of water due to defective local pipes and bad house plumbing and to incessant flow from the faucets, by which water is wasted to the extent probably of one-third of the entire supply afforded.

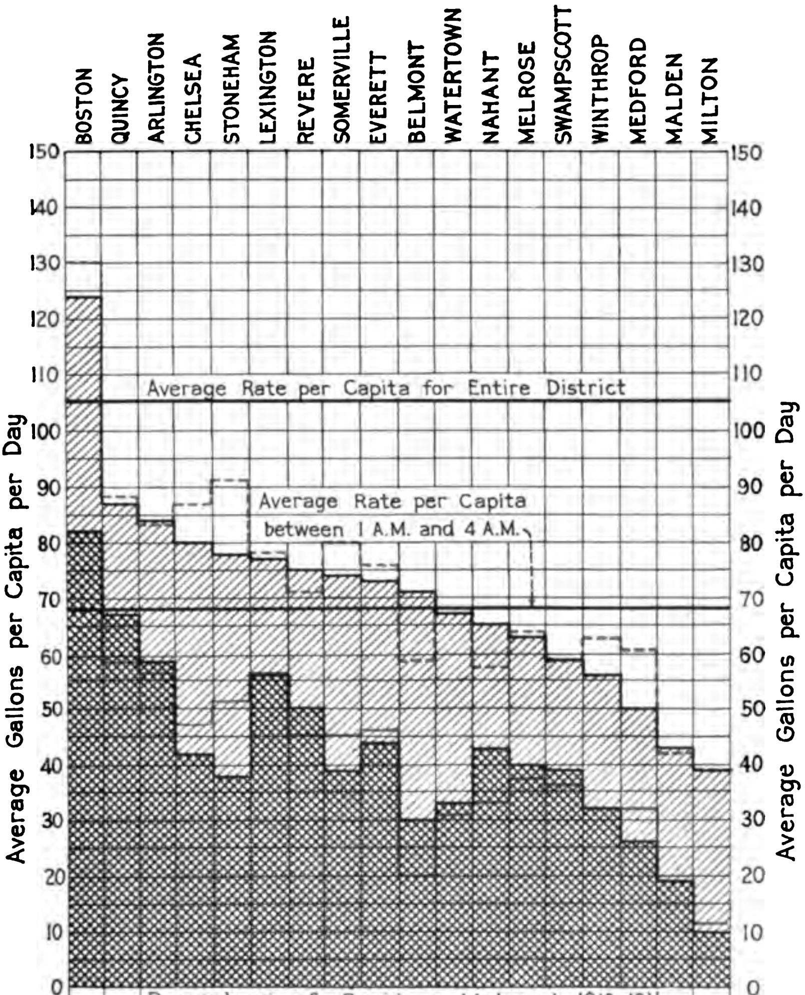
This situation demands more careful supervision on the part of the responsible authorities of the various cities and towns and the adoption of rigorous measures of prevention. Unless such means of checking the unnecessary and wasteful consumption shall be taken by the local authorities it would seem that the Legislature may be called upon to impose upon metropolitan agents the duty of exercising such supervision and inspection, not only in the interest of economy for the District and of delaying the time when additional sources of supply must be sought and new and extensive works be constructed, but also in behalf of the remote communities of the Commonwealth whose properties and rights will have to be yielded up for the benefit of the Metropolitan District. All reasons demand of the Metropolitan cities and towns the adoption of proper measures for the conservation of the present water supply and the limitation of the consumption of water to the legitimate and necessary requirements of their people.

The accompanying diagram, similar to that which has been given in past reports, showing the average rate of consumption in the past year during the entire day and between the hours of 1 and 4 in the morning, graphically illustrates the need of renewed attention to the subject of unnecessary and wasteful consumption, as well as the influence of the general use of meters prevailing in a portion of the cities and towns of the District.

In addition to the quantity of water which is supplied to the cities and towns of the Metropolitan District a total of 1,260,622,200 gallons, an equivalent of 3,453,700 gallons per day, have been drawn from the Metropolitan Water sources at various points for the benefit of places outside of the District, for which the sum of $11,820.29 has been received during the year.

In accordance with the provisions of the Legislature the city of Worcester has diverted from the Wachusett watershed a total of 759,800,000 gallons for its uses, and the town of Framingham, by like provisions, has drawn from Farm Pond and the Sudbury Aqueduct for its water supply 264,000,000 gallons, for which compensation is provided.

DIAGRAM SHOWING
AVERAGE RATE OF CONSUMPTION OF WATER IN THE METROPOLITAN DISTRICT IN 1911
DURING THE ENTIRE DAY
AND
BETWEEN THE HOURS OF 1 AND 4 AT NIGHT



Percentage of Services Metered 1910-1911

	BOSTON	QUINCY	ARLINGTON	CHELSEA	STONEHAM	LEXINGTON	REVERE	SOMERVILLE	EVERETT	BELMONT	WATERTOWN	NAHANT	MELROSE	SWAMPSCOTT	WINTHROP	MEDFORD	MALDEN	MILTON
Dec. 31, 1910	20.0	36.1	62.8	64.3	43.3	56.8	26.0	47.8	22.0	100.0	100.0	42.7	100.0	99.1	95.9	94.4	96.3	100.0
Dec. 31, 1911	27.3	62.0	70.4	94.3	55.4	69.7	34.9	53.2	28.5	100.0	100.0	50.8	100.0	100.0	100.0	100.0	95.8	100.0

Daily Average Rate of Consumption 1911 .... ▨

" " " Night " between 1 A.M. and 4 A.M. 1911 ▩

Daily Average Rate of Consumption in 1910 shown in Red.

Under permanent arrangements made with the Board, water to the amount of 53,053,000 gallons has been furnished for its main supply to the Westborough State Hospital from the open channel of the Wachusett Aqueduct; and, directly from the Metropolitan Works, 32,598,000 gallons have been furnished to the United States Government for its uses on Peddock's Island; and 4,782,500 gallons have been supplied to a portion of the town of Saugus which is connected with the water works of the town of Revere.

Under the recent statute authorizing the Board to furnish water to cities and towns outside of the District in cases of temporary emergencies, the town of Wakefield was in the latter part of the year supplied with a total of 83,948,700 gallons, and the city of Worcester with 62,440,000 gallons.

Although it does not in any degree afford a reason or excuse for neglecting any means which may be possible for conserving the supply for the future, it is gratifying that, notwithstanding the almost unprecedented small amount of rainfall following a series of dry years unknown to the past records, the Metropolitan District has during the past year been brought neither to inconvenience nor apprehension on account of the scarcity of water, and has been able to assist two other communities in the emergencies which they have suffered.

X. RECOMMENDATIONS FOR LEGISLATION.

In its preliminary report to the Legislature the Board has not asked for authority to construct any additional works for the Metropolitan Water System, and the loans already authorized are deemed sufficient for the completion of the works in progress. Neither has any construction been called for in the South Metropolitan Sewerage System.

The Board has, however, been compelled to ask for authority to proceed to supply new screening machinery for the East Boston pumping station and to construct a supplementary sewer in the Mystic valley, both of these works being in the North Metropolitan Sewerage System. The reasons for these requests are given in the preliminary annual report as follows: —

> The original plan for the improvement and extension of the East Boston pumping station contemplated new screening machinery. The amount esti-

mated as necessary for the purpose, however, was not included in the appropriation as made by the Legislature. Now that the other work has been completed the Board deems it advisable to remedy the defects existing in this machinery. The screens are now operated under ground in a deep pit, and their operation is not only difficult and unsanitary, but is expensive and uneconomical. The Board, therefore, has recommended that authority be given to acquire additional land and to provide new machinery for the purpose. The sum of $28,000 is estimated as the amount necessary to accomplish the improvement.

The Board finds itself compelled to call attention to the situation relative to the disposal of the sewage in the Mystic Valley and to recommend that measures be taken for the relief of the conditions which now prevail there.

The Metropolitan Sewerage Commission, as early as the year 1890, planned to dispose of the sewage and manufacturing wastes of the city of Woburn and the towns of Winchester and Stoneham by purchasing from the city of Boston the old Mystic Valley sewer, which had been originally constructed to protect the Mystic water supply, and by building in addition a new Metropolitan sewer. It was anticipated that the two sewers would be sufficient in the natural course of events to provide for this district for a long period of years. Since the date when this system was projected there has been a large and unanticipated increase in population in this region, due in part to more extended transit facilities, and there has also been a large growth in the tanning and other manufacturing establishments.

The quantity and character of the sewage and of other matters which are received in the Metropolitan sewers have been a subject of serious consideration for several years. The Board has caused the adoption of various measures for meeting the difficulties existing and for the purpose of postponing the time in which a supplementary sewer shall be required for the Mystic Valley. There has been a substantial compliance with the requirements of the Board that the tanneries and other manufacturing establishments should prevent, by settling tanks or otherwise, the entrance into the sewers of the objectionable wastes which not only increase the volume of matter received, but, being of a glutinous character, clog the sewers and decrease their carrying capacity. There are, however, very large quantities of liquids discharged into the sewers from these establishments, and a great increase in these quantities seems imminent in the near future on account of projected extensions of existing works and erection of new establishments. At the same time there is a large and steady increase in the population contributing sewage.

The old Mystic Valley sewer and the additional Metropolitan sewer, constructed by the Metropolitan Sewerage Commission have a combined maximum capacity at the point where the old Mystic sewer ends of about 14,000,000 gallons per day. This capacity has at times not only been reached but in certain periods of successive hours in the day has been greatly exceeded, having reached a maximum of discharge of about 17,300,000 gallons per day and in a few cases in the past there have been actual overflows from the manholes. There have been like overflows from the local sewers.

Very recent events have tended to hasten the Board to the conclusion that it should now advise entering upon the construction of a new supplementary sewer during the present year.

The town of Winchester has in the past year entered upon certain large improvements affecting the Aberjona River and the region through which the present sewers pass, which, if carried out, will seem to demand a change and improvement in the sewage disposal.

The Legislature of last year by chapter 291 authorized and directed the State Board of Health to prevent the entrance or discharge of sewage or any other substance, which might be injurious to the public health or might tend to create a public nuisance, into any part of the Aberjona River or its tributaries, and the statute further provides that whoever permits the entrance or discharge therein of any sewage or other such substance shall be punished by a fine not exceeding $500 for each offense.

It is the opinion of our engineers, notwithstanding the disposal of the objectionable factory wastes in tanks, which has been effected recently, that under present possible circumstances times may occur, as in the past, when it will be impossible to convey away all the sewage matter entering the two sewers and consequently to prevent overflows directly or indirectly into the Aberjona River.

To keep the sewers in the present condition so as to dispose of the sewage, as it has been accomplished, has required extraordinary inspection and constant cleaning and flushing and enforcement of regulations, involving an expense of nearly $10,000 a year, the larger part of which would not be required if a new sewer as projected be built.

It therefore seems to the Board that it cannot longer delay in asking for authority to begin the construction of a supplementary sewer during the coming year.

Such a new sewer as recommended by the engineers would extend from a point near the boundary line between the city of Woburn and the town of Winchester and after making connection with the Stoneham branch proceed through the congested district of Winchester and join the existing large Metropolitan main sewer in West Medford, whence this main has a safe carrying capacity for the whole district for many years to come. This new sewer as proposed would have a length of about 3.2 miles and a size varying from 3 feet to 4 feet in diameter, with a carrying capacity of about 22,000,000 gallons per day. The cost of its construction is estimated at $350,000.

The Board therefore recommends that the necessary authority be given for the issuance of bonds to the amount of $378,000 on account of the Metropolitan Sewerage Loan Fund, North System, in order to provide for supplying the screening machinery at the East Boston pumping station and for the construction of the supplementary sewer in the Mystic Valley.

XI. FUTURE WORK.

The Board has estimated that the maintenance and operation of the works for the water supply and its distribution to the cities and towns of the Metropolitan Water District will require for the current year the sum of $426,000, and of the works for the collection of sewage in the Metropolitan Sewerage Districts and its disposal will require an expenditure of $268,050, a total estimated expenditure for the current year of $694,050. Although this total estimated as necessary to be expended is about $20,000 greater than that of last year, largely by reason of the acts of the Legislature amending the eight-hour law and establishing $2.25 a day as the minimum wage of laborers, the total which will be required to be assessed upon the District will, it is anticipated, be less than that called for last year, on account of the income arising from the operation of the Wachusett power plant.

The estimates of the amount required include a request for the sum of $20,000, which may be expended by the Board from time to time for the protection and improvement of the water supply, as new menaces to the purity of the water upon the different watersheds appear, or as the sources of danger become more threatening.

There remains to be completed, as already authorized, a portion of the 60-inch main pipe line which is to constitute a second main for bringing the supply of water from the terminus of the Weston Aqueduct to the Chestnut Hill Reservoir, the part to extend from the Charles River to Valentine Street in Newton, a distance of about 14,400 feet, not yet having been constructed. It is anticipated that the portion of the line completed will relieve the pressing immediate needs and that it will not be necessary to enter upon the construction of the remainder of the line during the coming season.

The extension of the main pipe line from Forest Hills to the central portion of Hyde Park in order to furnish a water supply to that district, which has now become a part of the city of Boston, has been nearly completed. A new pumping station which is necessary in order to supply water to that section with the pressure which is ultimately desired has been begun and will be erected in the coming season. Two new pumping engines will be installed in the station.

While the construction of no large water works is called for in the coming year, considerable engineering labor will be necessary in order to bring to entire completion, with the necessary record plans, the works which have been recently finished or are near completion.

The Board has been called upon to make investigations and furnish information relative to supplying water to municipalities not now included in the Metropolitan Water District, and it does not seem improbable that, owing to the scarcity of the water supply in several cities and towns during the past year, the Board will be called upon by the Legislature at the present session to construct works in order to furnish a water supply to some other municipalities not now included in the Metropolitan Water District.

The Board has made in its preliminary report to the Legislature recommendations for construction which, if adopted, will require extensive work upon the North Sewerage System, these being the provision of new screening machinery in connection with the improvements at the East Boston pumping station, and the building of an additional main sewer in the Mystic valley.

The Board has still under consideration the adequacy of the present works properly to dispose of the large amount of sewage which is discharged into the harbor from the Deer Island outlet, and it is probable that some measures will be called for in the early future in order to provide a better and more effective method by which the sewage shall be disposed of when discharged into the sea.

The detailed reports of the Chief Engineer of the Water Works and of the Chief Engineer of the Sewerage Works, with various tables and statistics are herewith presented.

Respectfully submitted,

HENRY H. SPRAGUE,
HENRY P. WALCOTT,
JAMES A. BAILEY, Jr.,
Metropolitan Water and Sewerage Board.

Boston, February 26, 1912.

REPORT OF CHIEF ENGINEER OF WATER WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — The following is a report of the work done under the charge of the Chief Engineer of the Metropolitan Water Works for the year ending December 31, 1911.

GENERAL STATEMENT.

The Chief Engineer has charge of the design and construction of all new works, and of the maintenance and operation of all the works controlled by the Metropolitan Water and Sewerage Board for supplying water to the eighteen municipalities which have received their supply from the Metropolitan Works.

ORGANIZATION.

The Chief Engineer has had the following assistants: —

William E. Foss, . .	*Assistant to Chief Engineer.*
Elliot R. B. Allardice, .	*Superintendent, Wachusett Department.*
Charles E. Haberstroh,	*Superintendent, Sudbury Department.*
Samuel E. Killam, .	*Superintendent, Pipe Lines and Reservoirs, Distribution Department.*
Arthur E. O'Neil, .	*Superintendent, Pumping Stations, Distribution Department.*
Alfred A. Doane, . .	*Division Engineer, specially in charge of engineering work at pumping stations.*
Barzillai A. Rich, .	*Assistant Engineer, employed until December 20, 1911.*
Clifford Foss, . . .	*Assistant Engineer.*
Benjamin F. Hancox, .	*Assistant in charge of Drafting Department.*
James W. Killam, .	*Assistant Engineer, in charge of tests of coal and oil.*
William E. Whittaker,	*Office Assistant.*
Arthur W. Walker, .	*Biologist.*
William W. Locke, .	*Sanitary Inspector.*

At the beginning of the year the engineering force, including those engaged upon both the construction and maintenance of the works, numbered 51, and at the end of the year, 46. The average force was constituted as follows: —

Chief Engineer,	1
Department Superintendents,	4
Division Engineers,	2
Assistant Engineers,	7
Assistant Engineer and Sanitary Inspector,	1
Draftsmen,	3
Instrumentmen,	7
Rodmen,	6
Inspectors,	2
Office Assistant,	1
Biologists,	2
Sanitary Inspectors,	2
Stenographers,	4
Clerks,	5
Photographer,	1
Messengers,	2
	50

There has also been a maintenance force, exclusive of the engineers above mentioned, averaging 225, employed in the operation of the several pumping stations and in connection with the maintenance of the reservoirs, aqueducts and pipe lines, and in doing minor construction work.

The number of men employed in the maintenance force of the several departments has been as follows: —

	Beginning of Year.	End of Year.	Average.
Wachusett Department,	39	47	47
Sudbury Department,	56	44	51
Distribution Department, pipe lines and reservoirs,	91	68	71
Distribution Department, pumping service,	58	60	56
	244	219	225

In addition to the men employed directly by the Board, a force averaging 79 men, reaching a maximum of slightly less than 200 in September, was employed from March 20 to December 15 by the contractors engaged in constructing new works.

CONSTRUCTION.

60-Inch Supply Main from the Weston Aqueduct.

This work was authorized by the Legislature in 1909, and a contract for furnishing 8,000 tons of 60-inch pipes was made in that year. Contracts for laying the pipes, for the construction of a concrete-lined rock tunnel, and for 363 feet of cement-lined steel pipe were made in 1910. Two of the contracts, covering the laying of 16,920 feet of 60-inch pipe, were completed in that year. During the past year the contract with Joseph Hanreddy for building the tunnel and laying the steel and cast-iron pipes at both ends connecting with the 60-inch cast-iron pipes laid in 1910, has been completed, and the main was placed in service on November 4, 1911. At the end of the year 1910, Mr. Hanreddy had practically finished the excavation of the tunnel, 2,040 feet long, and had laid 664 feet of 60-inch cast-iron pipe. The work remaining to be done consisted of lining the tunnel and laying and lining the cement-lined steel pipe. Active operations were resumed during the latter part of March in cleaning and trimming the tunnel preparatory to placing the concrete lining. On April 14 the placing of concrete in the bottom of the tunnel was begun, with a force of 22 men and 2 mules. The method employed in lining the tunnel was as follows: The bottom of the tunnel was first covered with concrete to an elevation 9 inches below the elevation of the finished invert. Steel forms of the Blaw collapsible type were then set up and the side walls and top of the tunnel were formed, after which the forms were removed and the invert cleaned and filled to the finished grade. Each of these operations was begun near the centre of the tunnel and carried on toward each portal. The concrete lining, with the exception of grouting, was completed from Station 18 to the west portal on June 15, and to the east portal on August 11. In order that all voids between the concrete lining and the rock should be thoroughly filled, and for the further purpose of preventing leakage from the tunnel when subject to an internal pressure of 20 pounds per square inch, 1½ inch wrought-iron pipes were built into the lining of the tunnel, extending into the spaces above the lining which could not be thoroughly filled by hand labor. Through these pipes, which were spaced irregularly but an average of 17 feet apart for the whole length of the tunnel, there was forced 292 cubic yards of Portland cement grout under a pressure of 60 pounds per square inch. The grout was composed of equal parts of Portland cement and finely screened sand mixed dry, to which sufficient water was added to obtain a mixture which would flow freely through the interstices in the concrete and seams in the rock. The grouting was begun on September 21 and completed on October 3. Between October 19 and 23, the interior of the tunnel was scraped and coated with a wash of Portland cement.

Between Station 4 + 36 and Station 6 + 38 and between Station 26 + 73 and Station 28 + 34 riveted steel pipes 80 inches in diameter, lined with cement mortar and covered on the outside with concrete, were used to form the connection between the concrete-lined rock tunnel and the 60-inch cast-iron pipes. The steel pipes were furnished in sections about 20 feet long by the Hodge Boiler Works of East Boston, and were placed, riveted together, lined and covered by the contractor for building the tunnel. Each 20-foot section of the pipe was made of three alternately large and small courses, each course being formed of a single sheet of flange steel 6 feet, 11 inches wide and 5/16 of an inch in thickness. The longitudinal joints were lapped 4⅜ inches and double-riveted with ¾-inch rivets spaced 2⅞ inches from centre to centre. The circular joints were lapped 2½ inches and single-riveted with ¾-inch rivets spaced about 2⅛ inches on centres. At intervals of about 40 inches, pads 6 inches in diameter and ½ inch in thickness were riveted on top of the pipe, through each of which was drilled and tapped a hole for a 2-inch diameter steel plug.

The placing and riveting together of the 20-foot sections of steel pipe at the west portal of the tunnel was begun on July 10 and finished on July 22. At the east portal this part of the work was begun on August 21 and completed on September 12. After the steel pipes were riveted and calked, they were thoroughly cleaned both inside and out by the sand-blast process, and immediately afterward covered with a wash of Portland cement applied with a brush. The work of covering the exterior of the steel pipes at the west portal of the tunnel with Portland cement concrete was begun on July 27 and finished on August 11. At the east portal this work was done between September 18 and 28. The concrete surrounding the pipes is 9 feet 8 inches wide on the bottom and 6 inches in thickness over the top of the pipes. The lining of the pipes was done at the west portal of the tunnel between August 19 and September 15, and at the east portal of the tunnel between September 27 and October 13.

The pipes are lined with Portland cement mortar composed of one part of cement and two parts of sand. These materials were mixed with water in barrels which were supported on a platform placed about 4 feet above the pipes. Blaw collapsible steel forms were set up inside the pipes, leaving a space of 2 inches between the outside of the forms and the inside of the pipes, and the thoroughly mixed material was run into these spaces through 2-inch pipes inserted in the holes made in the top of the 80-inch pipes. The lining was applied in lengths of 14 feet. At the junctions between the 76-inch mortar-lined steel pipes and the 60-inch cast-iron pipes, 76-inch × 60-inch cast-iron branches were set and the 60-inch outlet capped, for use when an additional main shall be required. The work of refilling and surfacing the trenches at the tunnel portals, removing the contractor's plant, replacing fences, etc., was completed on November 25.

At the end of the year there remained about 2,800 cubic yards of broken stone, suitable for concrete, and 1,500 cubic yards of stone dust, suitable for surfacing sidewalks and roadways.

The cost of the work done by Joseph Hanreddy under his contract was $114,472.13.

The maintenance force in July made the connection at Valentine Street in Newton between the 60-inch main laid by Cavanagh Brothers in 1910 and the 48-inch Metropolitan main laid in 1902. The cost of connecting the 48-inch pipe, setting the branch, laying the connecting pipes, setting a 36-inch valve, and doing all incidental work, was $1,421.64.

A leak due to a cracked pipe was discovered a short distance west of Walnut Street when the pipe line was being tested. The substitution of a perfect pipe cost $289.23.

The leakage from this main, as determined by meter measurement before the main was placed in service, was 6 gallons per minute for 16,928 feet of 60-inch main, and 19 gallons per minute for 2,035 feet of concrete tunnel and 363 feet of 76-inch cement-lined steel pipe.

The cost of all work in connection with the new main from a point near Valentine Street to the connection on Beacon Street near Chestnut Hill Avenue, a distance of 20,252 feet, to December 31, 1911, was $455,090.25, as follows: —

17,854 Feet of 60-inch Cast-iron Pipe.

Pipes, special castings and valves,	$215,198 10
Venturi Meter,	2,350 00
Laying pipes, including pipe-laying materials and earth excavation,	66,086 35
Rock excavation,	13,327 66
Valve chambers and concrete backing for curves,	2,820 65
Work in connection with changes in underground structures,	6,849 74
Resurfacing trench in Commonwealth Avenue, Newton, labor by city of Newton,	4,357 16
Making connections, testing and putting lines in operation,	10,703 48
Real Estate,	290 40
Engineering,	16,380 00
Total,	$338,363 54

Cost per foot, $18.95.

363 Feet of 80-inch Steel Pipe.

Steel pipe,	$3,725 57
Laying steel pipe, lining with mortar and covering with concrete,	6,113 69
Earth excavation,	4,138 01
Rock excavation,	2,538 25
Engineering,	383 00
Total,	$17,353 52

Cost per foot, $47.81.

2,042.5 Feet of 76-inch Pressure Tunnel in Rock.

Tunnel excavation,	$51,074 40
Crushing stone,	7,334 25
Concrete tunnel lining,	31,568 81
Grouting tunnel,	3,696 50
Extra work on shafts at old Cochituate Aqueduct tunnel, and miscellaneous,	800 00
Legal conveyancing and expert,	100 55
Engineering,	4,798 68
Total,	$99,373 19

Cost per foot, $48.65.

NEW SUPPLY MAIN TO EAST BOSTON.

The construction of an additional main for the supply of East Boston was begun in 1910, and the work was quite fully described in the report for that year. At the beginning of 1911 the work remaining to be done was the completion of the laying of the 36-inch pipes in the tunnel under Chelsea Creek, and of connecting the pipes in the tunnel with the pipe lines in East Boston and Chelsea, also the filling of the tunnel and shafts with Portland cement concrete and constructing chambers on top of the shafts. This work was completed on January 28, and the main was placed in service on February 17.

The tunnel was built and the pipes were placed in the tunnel by day labor, under the supervision of Charles A. Haskin. The work of laying the pipes connecting the pipes in the tunnel with the mains of the City of Boston in East Boston and with the pipes laid by contract in Chelsea, including the work of setting a Venturi meter and the making of the joints in the pipes through the tunnel, was done by the maintenance force.

A test of the portion of the pipe line laid in Chelsea streets, comprising 725 feet of 30-inch pipe and 2,876 feet of 36-inch pipe, showed a leakage of 2 gallons per minute, and a test of the portion, 812 feet in length, including the tunnel, showed a leakage of 3.2 gallons per minute.

The cost of the whole work was $91,960.49, as follows: —

729 Feet of 30-inch and 3,214 Feet of 36-inch Cast-iron Pipe in Public Streets.

Pipes and special castings,	$23,150 04
Laying pipes, including pipe-laying materials and earth excavation,	6,830 90
Pile driving and timber foundation,	3,533 08
Valve chambers and concrete backing for curves,	579 00
Work in connection with changes in underground structures,	2,357 71
Making connections, testing and preparing lines for service,	3,655 88
Engineering and preliminary,	2,293 26
Total,	$42,399 87

Cost per foot, $10.75.

504 Feet of 36-inch Cast-iron Pipe in Tunnel under Chelsea Creek.

Pipes and special castings,	$4,386 15
Tunnel excavation,	20,400 73
Brick lining,	10,544 36
Laying 36-inch pipe in tunnel,	4,054 72
Concrete protection for pipes in tunnel,	5,737 13
Testing line and miscellaneous expenses,	873 65
Legal, conveyancing and expert,	42 80
Real estate,	900 00
Engineering,	2,621 08
Total,	$49,560 62

Cost per foot, $98.33.

PUMPING ENGINE FOR SOUTHERN HIGH SERVICE.

The 40,000,000-gallon triple expansion crank and fly-wheel engine for which a contract was made in 1909 with the Holly Manufacturing Company, was first operated on March 27. This engine was operated 4,174 hours and 32 minutes during the year, equivalent to 173 days, 22 hours and 32 minutes, but the official duty trial has not as yet been made.

Two boilers for supplying steam to this engine have been furnished by the Robb-Mumford Boiler Company of South Framingham. One of these was delivered late in December, 1910, and the other on January 2, 1911. They were unloaded from the cars and placed in position in the boiler-room by F. Knight & Son, Corporation, for the sum of $600.

The steam pipes forming the connections with the existing pipes in the boiler-room were furnished by The Lumsden & Van Stone Company, for the sum of $447; and the Chapman Valve Manufacturing Company furnished eight 5-inch, one 6-inch and one 8-inch valve for $362.98. The covering of the boilers, steam pipe and smoke flues with magnesia plastic covering was done by the Philip Carey Company, for $739. Railings and galleries for use in the boiler-room and the bridge connecting Engines Nos. 7 and 12 were furnished by The Lumsden & Van Stone Company for $553.48.

The erection of steam piping, boiler flues and fittings, and of the galleries and railings in both boiler and engine-rooms was done by the regular employés at the station. The work of connecting the discharge pipes from the engine with the 36-inch and 30-inch mains in front of the pumping station, consisting of about 100 feet of 36-inch pipe and two 36-inch hydraulic valves, together with the covering of the hydraulic valve chamber and the construction of six brick chambers over valves outside the building, was done by the maintenance force at a cost for materials and labor of $5,570.07.

The cost of all the work connected with the installation of these engines, including the connecting pipes in the vicinity of the pumping station, to Dec. 31, 1911, was $132,397.36, as follows: —

Pumping Engine.		
Engine No. 12,	$85,000 00	
Hydraulic valves, pipes and special castings,	3,515 54	
Labor and supplies for engine foundation and miscellaneous work,	9,223 31	
Total,		$97,738 85
Boilers.		
Boilers Nos. 15 and 16,	$10,448 00	
Fuel economizer,	1,740 00	
Hauling and erecting boilers,	600 00	
Smoke flue,	536 00	
Grates,	437 75	
Non-conducting covering for boilers, steam pipes and flues,	739 00	
Steam pipes,	447 00	
Railings and galleries,	553 48	
Valves and special castings,	366 25	
Labor and supplies for boiler foundations and miscellaneous work,	3,138 38	
Total,		19,005 86
Engineering.		
Engine No. 12 and Boilers Nos. 15 and 16,		4,743 21
Total for machinery,		$121,487 92
Connecting Pumping Engine to Existing Pipe Lines.		
Pipes, special castings and valves,	$5,924 45	
Labor and supplies for pipe laying, and miscellaneous work,	3,938 16	
Engineering,	1,046 83	
Total,		$10,909 44

EXTENSION OF WORKS TO HYDE PARK.

On March 28, 1911, the town of Hyde Park applied to the Board for a supply of water from the Metropolitan Works. On May 18, 1911, an act of the Legislature was approved authorizing the expenditure of $212,000 for the construction of the necessary extension of the works. The amount appropriated is expected to cover the cost of the 24-inch main 10,200 feet long, extending from Morton Street at Forest Hills through Hyde Park Avenue to the Hyde Park line; a pumping station located at the end of the 24-inch main, containing two engines, each of 3,000,000 gallons capacity in 24 hours; a 20-inch main 6,700 feet long, extending from the pumping station through Hyde Park Avenue to Cleary Square, where it connects with existing mains in Hyde Park. The appropriation also covers the cost of a 20-inch main about 3,000 feet long from the pumping station to a connection with the pipes of the city of Boston at the junction of Poplar and Beech streets in West Roxbury. Through this pipe water is to be pumped to the standpipe on Bellevue Hill for the supply of the highest portions of West Roxbury, Hyde Park and Milton.

A contract for furnishing 2,561 tons of pipes and 71 tons of special castings for the work was made with the United States Cast Iron Pipe & Foundry Company on May 24, 1911. A storage yard was leased at Hyde Park from the New York, New Haven & Hartford Railroad, and fitted with a derrick for handling the pipes. The pipes began to arrive in the latter part of April.

The work of laying pipes for the Hyde Park extension has been done under three contracts.

Contract No. 341 for Section 39 was awarded to Michele Russo & Son on June 24. This contract included the laying of 10,086 feet of 24-inch pipe from Morton Street in Forest Hills Square through Washington Street, Walkhill Street and Hyde Park Avenue to the Hyde Park line. The work was begun June 28. Pipe laying was completed on November 30, and the work of refilling and resurfacing the trenches on December 12. At Station 47, where the pipe line is carried over the channel of Stony Brook, 36 feet of riveted steel pipe were used in place of cast iron pipe; and at the crossing over the new channel which is being constructed for Stony Brook in Walkhill Street, a temporary line of 24-inch cast-iron pipe about 100 feet in length was laid.

The maintenance force of the department laid the steel pipe and constructed a box at the Stony Brook crossing, laid the temporary line over the new channel of Stony Brook, laid 20 wooden insulating joints, set seven 1½-inch air valves and tested the work.

The test showed a leakage of 7 gallons per minute.

Contract No. 343, for Section 40, included the laying of 6,731 feet of 20-inch main from the terminus of the 24-inch main at a point near the Hyde Park line, through Hyde Park Avenue to Cleary Square in Hyde Park. This contract was awarded to James L. Bryne, of Dorchester, on July 12. Trench excavation was begun July 21 and the contractor finished the work on November 11, including the laying of 259.6 feet of 24-inch, 324.5 feet of 20-inch pipe and 121.5 feet of 6-inch and 12-inch pipe not included in the original contract.

The maintenance force made 15 insulating joints of wood, set four 1½-inch air valves and made the connection between the 20-inch main and the 12-inch Metropolitan extra high service main in Metropolitan Avenue. The test of this main showed a leakage of 2.3 gallons per minute.

Section 41 included a 20-inch pipe line from the pumping station on Hyde Park Avenue, crossing the New York, New Haven & Hartford Railroad, thence through Grew Avenue, Mansur, Burleigh, Dale and Poplar streets to Beech Street, a distance of 2,984 feet. Contract No. 344, for laying this pipe, was made with Andrew M. Cusack, of Boston, on August 28, who began work on August 29, and completed his contract on November 21. At the crossing of the New York, New Haven & Hartford Railroad eleven lengths of flexible ball and socket joint pipes were used in place of pipes with the ordinary leaded joint, for the purpose of preventing leaks at the joints, due to jar from the trains.

The maintenance force made the connections with the pipes of the city of Boston at the junction of Beech and Poplar streets, set two 1½-inch air valves and did considerable work in building an embankment over a portion of the pipe line in Mansur Street and Grew Avenue. The test of this line showed a leakage of 5 gallons per minute.

Land having an area of 61,928 square feet, lying between Hyde Park Avenue and the New York, New Haven & Hartford Railroad has been acquired, plans for a pumping station have been so far perfected that the coal pocket and engine and boiler house foundations are now under construction, and a contract has been made for making and installing two pumping engines. Plans and specifications for the pumping station superstructure and for the boilers are being made, and it is expected that the plant will be completed in readiness for operation before the first of December, 1912.

The work of excavating for the building foundations, grading the grounds, and for a side track which is to be constructed by the Railroad Company, was begun on October 18 by a day-labor force under the supervision of the engineering department. The work done by this force to the end of the year included 4,006 cubic yards of excavation, 339 cubic yards of concrete masonry in building foundations, and the laying of cast-iron and Akron pipe for sewers and drains.

A contract made on Sept. 18, 1911, calls for the construction and erection in readiness for use on or before Sept. 18, 1912, of two horizontal duplex compound engines, each having a capacity of 3,000,000 gallons in 24 hours. The contract price for the two engines is $16,600.

Although the pumping station will not be completed for nearly a year, the mains connecting the Metropolitan Works with the distribution system of Hyde Park are in readiness for use.

The cost of work in connection with the extension of the supply to Hyde Park to Dec. 31, 1911, was $112,584.36, as follows: —

134.4 Feet of 20-inch and 10,468.1 Feet of 24-inch Cast-iron Pipe, Section 39.

Pipes, special castings and valves,	$30,312 76
Laying pipes, including pipe-laying materials and earth excavation,	11,516 63
Rock excavation,	2,742 00
Valve chambers and concrete for bracing curves, and foundation for paving,	1,155 00
Work in connection with changes in underground structures,	1,794 72
Filling and testing main and preparing it for service,	1,602 81
Engineering and preliminary,	2,032 76
Total,	$51,156 68

Cost per foot, $4.82.

6,810 Feet of 20-inch Cast-iron Pipe, Section 40.

Pipes, special castings and valves,	$17,884 60
Laying pipes, including pipe-laying materials and earth excavation,	6,049 41
Rock excavation,	2,545 00
Valve chambers and concrete for bracing curves,	714 00
Work in connection with changes in underground structures,	599 59
Filling and testing main and preparing it for service,	889 43
Engineering and preliminary,	1,271 45
Total,	$29,953 48

Cost per foot, $4.40.

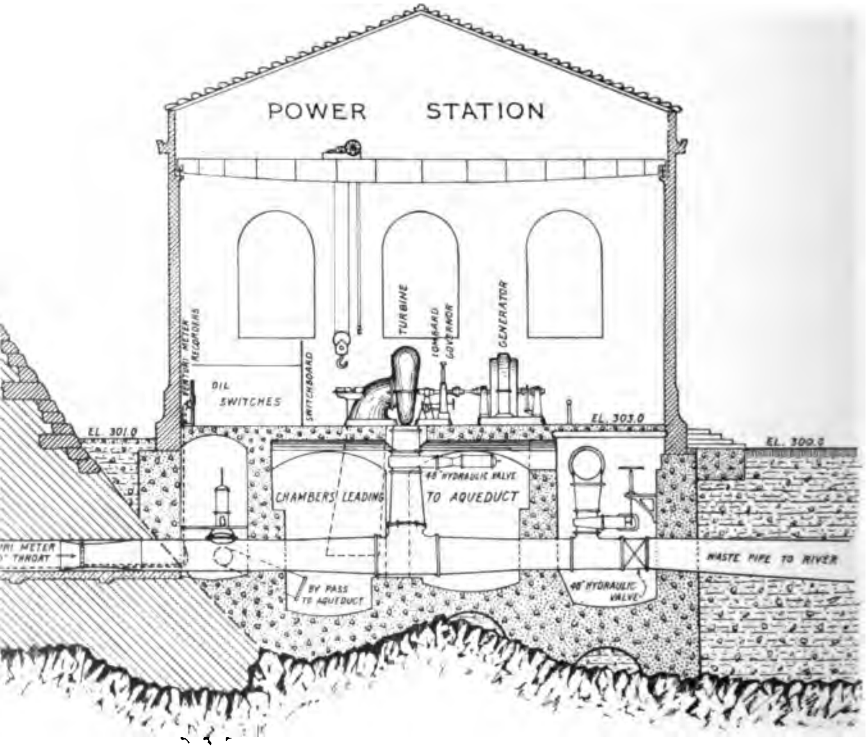
3,063.2 Feet of 20-inch Cast-iron Pipe, including 131.5 Feet of Flexible Jointed Pipe under 4-track Steam Railroad, Section 41.

Pipes, special castings and valves,	$8,037 53
Laying pipes, including pipe-laying materials and earth excavation,	5,094 61
Rock excavation,	145 00
Valve chambers and concrete for bracing curves,	482 00
Work in connection with changes in underground structures,	373 33
Making connection, building embankment over 600 feet of pipe line, testing and preparing line for service,	846 58
Engineering and preliminary,	1,078 77
Total,	$16,057 82

Cost per foot, $5.24.

Hyde Park Pumping Station — excavating and grading Lot and for Side Track, and constructing Concrete Foundations, etc.

Cast iron pipes and special castings,	$106 03
Excavating and grading, 4,006 cubic yards at 49.4 cents,	1,978 34
Concrete foundation walls, 339 cubic yards at $8.35 per cubic yard,	2,516 90
Gravel screened for concrete and not used,	363 65
Laying sewers, drains and miscellaneous work,	810 57
Engineering and preliminary,	2,608 11
Real estate, legal conveyancing and expert,	7,032 78
Total,	$15,416 38



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THROUGH GATE CHAMBERS AND POWER STATION

HYDRO-ELECTRIC PLANT.

In September, 1910, a contract was made by the Board with the Connecticut River Transmission Company, under which the Board agreed to furnish for a period of five years electrical energy to be developed at the Wachusett Dam in Clinton, by utilizing the fall of water drawn from the Wachusett Reservoir into the Aqueduct for use in the Metropolitan District.

On November 9, 1910, a contract was made with the S. Morgan Smith Company, of York, Pa., to furnish and install in the power house which was built in 1904, 4 hydraulic turbines and 4 electric generators, with a small generator to be used as an exciter, with the necessary wiring and switchboard. Contracts were also made for furnishing 4 48-inch hydraulic lift valves, 4 48-inch Venturi meters, and about 113 tons of castings 48 inches and 60 inches in diameter, for use in the penstocks supplying water to the turbines.

In February, the Niles-Bement-Pond Co. of Philadelphia completed the erection of a hand-operated traveling crane, for use in connection with the erection and maintenance of the power plant.

Work upon concrete foundations for the wheels and generators and for the floor of the power-house was begun by the maintenance department in the latter part of February. The large penstock castings arrived in March, and the work of setting them began immediately. During April and May the work of installing the penstock valves, Venturi meters, electric generators and switchboard, and of constructing the concrete foundations and floor, were in active progress, and during the last week of the month one of the turbines was received and its erection was begun.

The erection of the turbines and generators, the construction of a lightning arrester house and of underground and overhead transmission lines connecting the power-house with the lines of the Connecticut River Transmission Company were in progress during the months of June and July. On the first of August the plant was substantially finished, and between August 3 and 9 one of the turbines was tested to determine its efficiency.

The plant consists of 4 hydraulic turbines of the horizontal shaft, spiral case type, each equipped with a Type Q Lombard governor. Each turbine was guaranteed to develop 1,200 horse-power. The contract provided that the turbines, when revolving at a speed of 400 revolutions per minute under a net head of 90 feet, and when discharging, respectively, 73, 122, 138 and 155 cubic feet per second, should give an average efficiency of 82 per cent.

The average efficiency of the turbines as determined by Prof. C. M. Allen of Worcester, was 79.4 per cent., measuring the discharge into the Wachusett Aqueduct by the use of a current meter; and 81.6 per cent., measuring the discharge by the use of a pitometer placed in the penstock pipe. The average of these efficiencies was assumed to be the correct result in the settlement with the contractor.

The water supplying each of the wheels flows from the reservoir into a masonry chamber built in the dam, which is provided with screens, stop-planks and sluice valves, thence through a vertical well 7 feet in diameter extending to a depth of 111 feet below high water in the reservoir, thence through a 48-inch cast iron pipe extending horizontally 114 feet through the dam into a building in which are located the turbines and generators, as well as connections with the Wachusett Aqueduct and with waste pipes for conveying the water to the river below the dam.

In each of the 4 pipes leading to the wheels there has been placed a special type of Venturi meter furnished by the Builders Iron Foundry of Providence, R. I. These meters afford means for measuring the quantity of water used by each of the turbines, as well as the quantity drawn from the Reservoir for the supply of the Metropolitan District.

Each meter consists of a throat section 40 inches in diameter, 10 feet 4 inches long, made in two sections for convenience in inserting in the 48-inch pipes, and an upstream pressure chamber, consisting of a ring of 3-inch brass pipe set in a recess cut in the brick wall of the 7-foot diameter vertical wells. The distance from the throat of the meter to the pressure chamber is about 90 feet. Water is admitted to the upstream pressure chamber through 12 ½-inch openings in brass plates which are set flush with the sides of the well; and the pressures, both from the pressure chamber in the vertical well and from the throat of the meter, are transmitted to the recording instruments in the power station through ¾-inch diameter brass pipes.

The recording instruments have three dials; one indicating the rate of flow in million gallons per day, one for continuously recording this rate upon a chart, and one for registering the total flow through the meter.

Tests of these meters made by careful current meter measurements of the flow in the Wachusett Aqueduct, indicate that for rates of flow between 48,000,000 and 110,000,000 gallons in 24 hours the meters will register and record the flow within 2 per cent. of accuracy.

The wheels and generators are supported on a foundation of heavy concrete masonry forming wells, into some of which the draft tubes from the turbines discharge, while others contain valves controlling the flow of water.

In each penstock directly under the turbine there is placed a 48-inch valve operated by water pressure by means of a 24-inch diameter hydraulic piston. These valves, four in number, were furnished by the Pratt & Cady Company, of Hartford, Conn., for $1,267 each.

The generators and switchboard were furnished and erected by the Westinghouse Electric & Mfg. Co. of Pittsburg under a subcontract with the S. Morgan Smith Company.

There are four 1,000 kilo-volt-ampere horizontal-shaft machines, each directly connected with a turbine and delivering 3-phase 60-cycle current at a pressure of 13,800 volts. The available head on the wheels will be from 80 to 100 feet, depending upon the elevation of the water in the reservoir and the quantity flowing in the aqueduct.

The plant also includes a 110 horse-power hydraulic turbine furnished by the S. Morgan Smith Company, and a 90 horse-power turbine furnished by the Holyoke Machine Company, each of which is directly connected with a 125-volt direct current Westinghouse generator used in exciting the large alternating current generators, in operating the motors used for pumping out wells, and in operating the electric crane in the upper gate house. The energy developed by the main units is conveyed for a distance of 815 feet from the power house through two lines of 3-conductor paper insulated lead covered cable. Each conductor is composed of 19 strands of copper wire and has a conductivity equivalent to a solid No. 0 B. & S. gage wire. The cables were tested at the factory under a pressure of 30,000 volts and guaranteed for 5 years. Each cable was laid in a 3½-inch diameter

Orangeburg fiber conduit laid in Portland cement concrete. In connection with the transmission line a twin conductor lead-covered telephone cable was laid in a 2-inch diameter Orangeburg fiber conduit. The underground cables terminate at a point on the side of the waste channel near the Central Massachusetts Railroad. At this point is located a building 20 feet long and 14 feet wide, constructed of Portland cement concrete with a roof of red Imperial Spanish tile. This building contains the apparatus required for arresting electric currents due to lightning and preventing injury to the cables, generators and other apparatus at the power house. Between the lightning arrester house and the transmission line of the Connecticut River Transmission Company there is a pole line 600 feet long, supporting 6 lines of No. 1 7-strand bare copper wire, 1 No. 4 copper guard wire and 2 No. 10 telephone wires.

The concrete floor of the room occupied by the wheels and generators is covered with selected red American Promenade floor tiles. The cost of the plant, including the concrete foundations and tile floor, was as follows: —

4 1,200 H. P. turbines, 4 1,000 K. V. A. generators, 1 110 H. P. exciter turbine, 2 exciter generators and electric equipment furnished and installed by S. Morgan Smith Co. and Westinghouse Electric & Mfg. Co.,		$69,639 62
Lombard governor on exciter turbine,		935 12
Lightning arrester station,		2,348 44
Underground transmission line,		2,693 47
Overhead transmission line,		949 30
Labor and materials furnished in connection with the wiring in the building,		2,022 98
Penstock pipes and valves: —		
4 48-inch valves,	$5,068 00	
Special castings,	7,474 40	
Installing castings and valves,	2,832 59	
		15,374 99
4 Venturi meters and installation of same,		6,211 94
Floor of power station, including concrete foundations for turbines and generators,		7,883 29
Traveling crane,		2,500 00
Miscellaneous labor and materials,		3,020 27
Engineering,		9,521 06
		$123,100 48

The total includes the cost of four Venturi meters which are used in measuring the water drawn from the reservoir.

MISCELLANEOUS CONSTRUCTION.

For the purpose of increasing the capacity of the mains leading from the high service engines to the Fisher and Waban Hill reservoirs, about 45 feet of 20-inch and 24-inch pipes in front of Chestnut Hill Pumping Station No. 1 have been removed, and 200 feet of 36-inch pipe, connected with the old 30-inch main, have been laid in front of the station and connected with the 36-inch main leading to Waban Hill Reservoir. This work was done in May, at a cost of $3,880.76.

A Hersey detector meter, Type F.M., size 6 inches x 3 inches, was installed in January on the Fellsway at Fells Avenue, Medford, for use in measuring the water used in a small section of that city known as Boulevard Heights.

Venturi meters and registers have been set at Cleveland Circle in Brighton, and at the Hyde Park Pumping Station, and a Hersey detector meter and Ross regulating valve have been set at the corner of Summit Street and Milton Avenue in Hyde Park, for use in measuring the quantity used, and controlling the pressure in a small section of Hyde Park which is to be supplied from the southern extra high service.

ENGINEERING.

The work of the engineering force chargeable to construction has included the preparation of plans and specifications and the superintendence of work which has been in progress under twenty contracts aggregating about $300,000 in value.

The principal items of work have been the 76-inch cement-lined steel pipe line and concrete-lined pressure tunnel in Newton, the hydro-electric plant at the Wachusett Dam, including turbines, generators, valves and castings, the new pumping engine at Chestnut Hill Pumping Station No. 2, and the pipes, valves, pipe laying, pumping station and machinery for the extension of the works to Hyde Park. Preliminary studies, including estimates of cost, have been made for reservoirs in the Blue Hills Reservation in connection with the southern extra high service system and for pipe lines to supply water to the town of Braintree.

MAINTENANCE.

Rainfall and Yield.

The rainfall on the Wachusett watershed was 38.73 inches and on the Sudbury watershed 38.38 inches. Although the rainfall was somewhat larger than in 1910, it was so distributed throughout the year that both the percentage and total amount collected were smaller than during any year since records have been kept. On the Wachusett watershed 37 per cent. of the rainfall, equivalent to 14.33 inches, was collected, and on the Sudbury watershed 28.2 per cent., equivalent to 10.8 inches. The rainfall, rainfall collected, and yield in gallons per day per square mile for the past four years, as compared with the corresponding figures for the years 1880 to 1883, inclusive, which is the period of lowest previous record, are as follows: —

Year.	Sudbury River Watershed.			Wachusett Watershed.		
	Rainfall (Inches).	Rainfall collected (Inches).	Yield (Gallons per Day per Square Mile).	Rainfall (Inches).	Rainfall collected (Inches).	Yield (Gallons per Day per Square Mile).
1908,	36.15	14.62	694,000	37.83	17.84	847,000
1909,	41.75	13.13	625,000	44.50	19.27	918,000
1910,	35.64	11.96	570,000	37.85	17.39	828,000
1911,	38.38	10.80	514,000	38.73	14.32	682,000
Averages,	37.98	12.63	600,750	39.73	17.20	818,750
1880,	38.18	12.18	578,000	-	-	-
1881,	44.17	20.57	979,000	-	-	-
1882,	39.39	18.10	862,000	-	-	-
1883,	32.78	11.19	533,000	-	-	-
Averages,	38.63	15.51	738,000	-	-	-
Average for 37 years,	-	-	1,013,000	-	-	-
Average for 15 years,	-	-	-	-	-	1,107,000

Storage Reservoirs.

On January 1, 1911, the storage reservoirs contained 59,327,000,000 gallons, which is 21,581,900,000 gallons less than their capacity when full. By reason of the small rainfall during the early part of the year there was no gain in storage until after the 14th of March. During the latter half of March and the month of April there was a gain in the amount of storage, but the Wachusett Reservoir did not fill during the spring and the maximum storage, which occurred on May 2, was 67,953,900,000 gallons. This was about 10,000,000,000 gallons less than the maximum during any previous year since 1908, when the Wachusett Reservoir was first filled. From May 2 until October 15 there was a practically continuous loss of storage, interrupted for two weeks by a heavy rainfall on June 5 and 6, and for one week, by a rainfall of 3½ inches during the last week in August. On October 18 the reservoirs contained 55,503,900,000 gallons of water. A rainfall of about 10½ inches during the last two and a half months of the year caused a gain in storage of 4,476,100,000 gallons, and on January 1, 1912, the reservoirs contained 653,000,000 gallons more than at the beginning of the previous year.

The following table gives the quantity of water stored in the storage reservoirs at the beginning of each month: —

Quantity of Water stored in Wachusett Reservoir, and in Reservoirs on Sudbury and Cochituate Watersheds, at the Beginning of Each Month.

DATE.	In Wachusett Reservoir (Gallons).	In Sudbury Reservoir and Framingham Reservoir No. 3 (Gallons).	In All Other Storage Reservoirs (Gallons).	Total (Gallons).
1911.				
January 1,	45,610,400,000	7,890,400,000	5,826,200,000	59,327,000,000
February 1,	44,934,500,000	7,898,100,000	6,156,900,000	58,989,500,000
March 1,	45,416,100,000	7,694,800,000	6,057,900,000	59,168,800,000
April 1,	48,736,900,000	7,724,100,000	6,429,400,000	62,890,400,000
May 1,	53,705,700,000	7,200,500,000	6,974,800,000	67,881,000,000
June 1,	54,667,000,000	5,996,100,000	6,204,200,000	66,867,300,000
July 1,	54,153,200,000	6,009,400,000	5,189,700,000	65,352,300,000
August 1,	51,921,000,000	6,569,800,000	3,297,400,000	61,788,200,000
September 1,	49,806,000,000	6,406,000,000	2,745,700,000	58,957,700,000
October 1,	48,186,800,000	6,126,000,000	2,236,900,000	56,549,700,000
November 1,	48,027,400,000	5,730,900,000	2,358,900,000	56,117,200,000
December 1,	47,755,500,000	6,710,000,000	3,065,900,000	57,531,400,000
1912.				
January 1,	48,910,000,000	6,980,900,000	4,089,100,000	59,980,000,000

Wachusett Reservoir. — At the beginning of the year the water in this reservoir was at elevation 379.35, or 15.65 feet below high-water mark. The low-water mark for the year was 378.52 on January 27. On March 14 the elevation of the water was 378.69, after which date the reservoir rose until May 18, when it stood at elevation 387.09. The highest point for the year was reached on June

10, when the elevation was 387.41, or 7.59 feet below high-water mark. Between this date and the middle of October the reservoir fell 6.35 feet. During the remainder of the year the reservoir surface varied but little in elevation, but rose about 12 inches during the latter half of December. At the end of the year the reservoir was 2.95 feet higher than at the beginning, and contained 48,910,000,000 gallons, a net gain in storage of 3,299,600,000 gallons during the year.

The reservoir bottom between elevations 382 and 398 covering an area of over 600 acres, was cleaned between September 25 and November 8, for the first time since 1908. The perennials which had grown during the past three years were removed by pulling or grubbing; the annuals were pulled or mowed; the tree stumps, roots, logs and miscellaneous debris brought into the reservoir by flood water or unearthed by wave action on the shores were collected, and the entire surface was raked, all refuse burned and the residue buried or removed outside the limits of the reservoir. This work was done at a cost of $2,165.88.

No additional removal of soil along the shores of the reservoir has been necessary during the past year, but the timber was cut from a strip 50 feet wide and 975 feet long along the Sawyers Mills Bluff, in anticipation of further washing away of the shore at that place.

Wachusett Dam and Grounds. — The structures and grounds at the dam are in good condition. The hauling of heavy machinery and supplies to the lower gate house, in connection with the installation of the hydro-electric plant, and the excavation of trenches for electric conduits, has made necessary the repairing of the roadways on the grounds as well as the public highway leading to the dam from Boylston Street. By arrangement with the Road Commissioners of Clinton, this department furnished and placed screened gravel on 5,100 linear feet of roadway 20 feet wide, 960 feet of which was a town road but used almost exclusively by the Commonwealth, and the town of Clinton furnished a steam roller and wet and rolled the roadway for its entire length. These repairs were made in September at a cost of $818.11. The lawn at the foot of the dam, between the power house and the west hillside, has been regraded and a driveway built to afford access for teams to the door at the west end of the power station.

A one-story, concrete building, 32 feet x 23 feet, with a red tile roof, has been built on the grounds for use as a garage, in which to store the two automobiles used by the department, and as a storehouse for tools used in caring for the grounds about the dam. The cost of this building was $3,079.73.

Six additional screens of standard design have been made for use in the upper gate chamber, it having been found necessary to provide additional screen area in connection with the economical operation of the power plant.

Care and Improvement of the Wachusett Watershed. — In addition to the work described under the heads of Forestry and Swamp Drainage, the conditions on the Wachusett watershed have been improved by the acquisition of 130.408 acres of land, a large portion of which is of a swampy character and located on the line of brooks which flow directly into the reservoir.

Waushacum Brook, which forms the outlet of the Waushacum ponds and is one of the principal feeders of the Wachusett Reservoir, extends for over a mile through three of the properties recently purchased. For the whole distance the channel of the brook has been improved by widening, deepening and straightening, and a margin 15 feet wide has been cleared on both sides of the brook. This work was done at a cost of $666.45.

Thirty-five stone bounds have been set, marking the boundary of property purchased.

An old dam across Malden Brook, in West Boylston, on property formerly owned by Mary L. Warner, has been torn down and the brook cleaned and improved, thus removing a small objectionable pond and swamp.

The timber portion of the dam across the Quinepoxet River just above the site of Warfield's Mill has been removed and burned and the rock portion of the dam levelled so as to prevent the storage of water back of the dam during times of low water in the river.

The original plank covering of a large cesspool constructed to receive drainage from a barn on the premises of Andrew J. Scarlett, in West Boylston, has been replaced by a more permanent cover made of Portland cement concrete slabs supported on granite sills.

The standing and rowen grass from about 375 acres of land around the reservoir was sold for $2,690.

Emergency Supply for City of Worcester. — During the months of September and October the city of Worcester, by permission of the

Board, constructed upon the shore of the Wachusett Reservoir, at South Bay, in the town of West Boylston, a pumping plant designed to furnish an emergency supply of water to that city. The plant consists of three four-stage centrifugal pumps, each having a capacity of 2,000,000 gallons in 24 hours, connected by a belt to a 250 H. P. General Electric motor. Two additional motors were installed and foundations constructed for two additional pumps for use if they should be required. Each pump draws its supply through a 10-inch suction main supported on a timber platform extending into the reservoir, and all the pumps discharge into a common force main, 30 inches in diameter, through which the water is carried about 2¼ miles and discharged into the distribution system of the city of Worcester. The machinery is enclosed in a one-story wooden building 46 feet 2 inches wide x 69 feet 4 inches long, supported on concrete foundations. Pumping from the reservoir to the city of Worcester was begun at 3 P.M. on October 24 and continued, with some intermissions, until November 11, the total amount pumped being 62,440,000 gallons, for which the city of Worcester paid $1,810.76. The plant was operated by electricity furnished by the Connecticut River Transmission Company.

Sudbury Reservoir. — From January 1 to April 23 this reservoir was full, and during the greater portion of this period water was flowing over the crest of the dam. During the succeeding four weeks the reservoir was lowered about 4 feet, and from May 20 until November 20 the reservoir was kept between 3 and 5.5 feet below the crest of the dam. At the end of the year the water surface was 2 feet below the crest.

The wells, from which water is drawn to supply the Bigelow and Cratty houses owned by the Board and occupied by its employés, have been deepened and repairs made at both of these houses, also at the attendant's house at the Sudbury Dam.

A wire fence 825 feet long has been built on the line between property of the Board and Oren P. Walker, near the Marlborough filter-beds.

At the Sudbury Dam about 9 cubic yards of Portland cement concrete were used in filling holes at the foot of the overflow. Steel plates 19 inches x 25 inches in size, were placed in the sides of the casting below one of the pipe gates in the gate-house, and the iron standards for supporting flash-boards on the crest of the overflow have been painted.

Framingham Reservoirs Nos. 1, 2 and 3. — From June 18 to October 21 the surface of Framingham Reservoir No. 1 was below the crest of the dam, due to the discharge from this reservoir into the river of 1,500,000 gallons per day, as required by law. The lowest point reached was 1.17 feet below the crest of the dam, on August 25. At the end of the year water was being wasted over the outlet dam.

The water in Framingham Reservoir No. 2 was above the level of the crest of the dam from January 1 to July 24, with the exception of a few days in February and March. During August the surface was about 5 feet below the stone crest. During September the reservoir filled and for the remainder of the year the surface remained at or near high-water mark.

The elevation of the water in Framingham Reservoir No. 3 is controlled by the draft for the supply of the Metropolitan District and the quantity delivered into the reservoir from the Sudbury Reservoir. During the greater part of the year the surface of this reservoir was kept between one and two feet below the crest of the dam. The only time that any water was allowed to flow from this reservoir into Framingham Reservoir No. 1 was for a few hours on March 16, when the water rose above the top of the flash-boards on the dam.

The work of filling a shallow area at the head of Framingham Reservoir No. 3, which was begun in 1910, has been completed. The surface of the fill has been covered with about 6 inches of loam and sowed with grass seed. There were used in the fill 3,600 cubic yards of material at a cost of about 25 cents per cubic yard.

Advantage was taken of the low stage of the water in Framingham Reservoir No. 2 to clean and paint the upper pipe gate in the gatehouse. Granite bounds were set at 57 angle points on the property lines around Framingham Reservoir No. 2.

The embankments of the three dams were dressed with chemical fertilizer, and, judging from the appearance of the grass, the embankments can be kept in good condition at less expense by the use of chemical fertilizer than by the use of stable manure.

Ashland Reservoir. — At the beginning of the year the reservoir was full and overflowing, and it continued to overflow nearly all of the time until April 27. During the following three months water was drawn from this reservoir for use in the Metropolitan District at rates of from 10,000,000 to 30,000,000 gallons per day. On July 24, when the gates were closed, the surface of the reservoir was 33 feet below high-water mark, and the storage had been reduced from 1,421,900,000 to 157,200,000 gallons. At the end of the year this reservoir had risen to elevation 208.51 and contained 629,200,000 gallons. The sluice gates, gate stems and brackets were cleaned and painted and the stop-planks in the gate-house overflow, twenty in number, 4 feet 6 inches long, which were in poor condition, have been renewed. The embankment at the dam was given a dressing of chemical fertilizer.

Hopkinton Reservoir. — The water in this reservoir was 0.16 of a foot above the crest of the waste-way at the beginning of the year. From the middle of February to the middle of March 413,100,000 gallons of water were drawn in excess of the yield of the watershed, and the surface of the reservoir lowered 7.04 feet. After March 21 the reservoir surface rose steadily and the highest elevation for the year was reached on May 5, when the water stood at elevation 304.83, or 0.17 of a foot below high-water mark. On May 5 the valves on the outlet pipe were opened and on June 1 the reservoir surface had fallen 7½ feet, on July 1, 11 feet additional, and on July 24, when the outlet valves were closed, the reservoir was 32.82 feet below high-water mark, and contained but 138,000,000 gallons.

Advantage was taken of the low level of the water in the reservoir to clean and paint the sluice gates at the dam, with the exception of the lower guard gate, including the gates controlling the flow on the filter-beds. The filter-beds were harrowed in the spring and a growth of weeds and grass mowed and burned in the fall. The embankment of the dam was dressed with chemical fertilizer.

Whitehall Reservoir. — On January 1, 1911, the surface of this reservoir was at elevation 335.70. Water was drawn from the reservoir continuously from August 20 to October 3, to reinforce the storage in Framingham Reservoir No. 2, from which water was at that time being drawn for the supply of the Metropolitan District. This draft lowered the reservoir 2.15 feet. At the end of the year the reservoir surface was at elevation 336.13, or 1.78 feet below high water.

A portion of the retaining wall on the east side of the flume which passes through the outlet dam collapsed, and the old wall has been taken down and rebuilt in a more substantial manner. Five summer cottages have been built and there are now 59 cottages located near the shore of the reservoir.

Farm Pond. — No water was drawn from this pond during the year for use in the Metropolitan District, none was wasted from it to the Sudbury River and none supplied to it from the Sudbury Aqueduct. The town of Framingham has drawn the greater part of its supply from filter galleries located on the shore of the pond, and in June changed the connections between the filter galleries and the pumps so as to make it possible to draw the water from the filter galleries at a lower level.

In December an 8-inch Hersey proportional meter was set on the pipe connecting the Sudbury Aqueduct with the pumps supplying the town of Framingham, so that hereafter a more accurate measurement will be obtained of the quantity drawn from the aqueduct by the town of Framingham.

The total quantity of water used by Framingham was 264,000,000 gallons, of which 41,300,000 gallons were drawn from the Sudbury Aqueduct and the remainder from the filter galleries.

Lake Cochituate. — At the beginning of the year the water in the lake was at elevation 141.19, or 3.17 feet below high water. The lake was filled in the latter part of April and remained at or near high-water mark until July 1; from that date until October 23 water was drawn from the lake for the supply of the Metropolitan District, and its surface lowered about 8.5 feet, to elevation 135.81. During November and December the surface of the lake rose 4 feet and on January 1, 1912, stood at elevation 140.21.

The stone coping of the retaining wall alongside the driveway leading from Pond Street to the effluent gate-house has been reset for a distance of 390 feet, and willow cuttings set in loam back of the wall for the purpose of forming a hedge alongside the driveway.

An area of about half an acre, lying between Speene Street and the shore at the south end of the lake, on land belonging to E. E. Wilgus, which was slightly below the high-water level of the lake, has been filled so that it is now not less than 9 inches above high-water mark. This work was done at a cost of about $312.

While the water was at a low stage, the shores of the lake were cleaned at several points and the channel under Worcester Street was deepened so that water could be drawn from the upper end of the lake to a greater depth.

WORKS FOR DIVERTING SURFACE DRAINAGE OF COCHITUATE VILLAGE FROM LAKE COCHITUATE TO THE SUDBURY RIVER.

The construction of these works was nearly completed in 1910 and they were described in the report for that year. Since January 13, 1911, when the drains were placed in service, the surface drainage from about 140 acres, on which there is a population of 700, has been carried to Bannister's Brook, from which it flows to the Sudbury River. As soon as the frost left the ground in the spring the contractor completed his work by laying 15 feet of 12-inch pipe, surfacing the trenches and repairing concrete masonry which had been injured by freezing. For a distance of about 450 feet the open channel was carried through a shallow pond which was partially filled by the contractor with surplus material from other parts of the work. As there was not enough of the surplus material to complete the filling of the pond 1,267 cubic yards of gravel and loam were purchased at a cost of 48 cents per yard. This material was placed and the area graded by the regular maintenance force, who also constructed 1,150 feet of ditches, 700 feet of which are provided with plank bottom and paved side slopes.

On account of the sliding of the very fine material forming the side slopes of the open channel through land of Charles H. McIntyre it has been found necessary to repair the paved slopes and clean several hundred feet of the open channel. The experience of the winter of 1910–11 shows that Bannister's Brook brings down considerable fine sand, which deposits in a portion of the drain below the Cochituate Road, from which it cannot be easily removed. It is now proposed to construct a settling basin in which the sand will be deposited before entering the new channel.

Fences, having an aggregate length of 232 feet, have been built on both sides of the Cochituate Road and Speene Street, where the roads cross the open channel.

The cost of the drainage system to December 31, 1911, was $34,558.02, as follows: —

5,876 feet of open channel, Cost per foot, $2.25.	$13,239 88
3,454 feet of 36-inch x 33-inch concrete covered channel, Cost per foot, $3.94.	13,606 76
957 feet 24-inch, 167.5 feet 18-inch and 367 feet 12-inch pipe, 9 manholes and 14 catch basins, Cost per foot, $2.57.	3,828 20
2 culverts,	812 69
Filling pond hole and constructing ditches in same,	2,059 39
Miscellaneous,	1,011 10
	$34,558 02

SOURCES FROM WHICH WATER FOR THE SUPPLY OF THE METROPOLITAN DISTRICT HAS BEEN TAKEN.

An average of 65,580,000 gallons of water per day was drawn from the Wachusett Reservoir through the Wachusett Aqueduct into the Sudbury Reservoir. This was 37,566,000 gallons per day less than during the previous year, due to the use of a larger proportion of water from the Sudbury and Cochituate sources, and to a reduction in the total consumption. For the use of the Metropolitan District an average of 29,839,000 gallons per day was drawn from the Sudbury Reservoir through the Weston Aqueduct, an average of 22,792,000 gallons per day from Framingham Reservoir No. 2 and of 47,768,000 gallons per day from Framingham Reservoir No. 3 through the Sudbury Aqueduct, and an average of 9,522,000 gallons per day from Lake Cochituate through the Cochituate Aqueduct. The drainage area of Spot Pond furnished 208,000 gallons per day.

The quantity of water drawn from Framingham Reservoir No. 2 during the past year was very much larger than in any year since 1898, and of the quantity drawn from this source 8,300,000 gallons per day were drawn from the storage in the Ashland, Hopkinton and Whitehall reservoirs.

AQUEDUCTS.

The *Wachusett Aqueduct* was in use 4,755 hours and 12 minutes, equivalent to 198.13 days. Since August 10, when the hydro-electric plant was placed in operation, the greater part of the water supplied to the Sudbury Reservoir has been passed through the turbines before entering the aqueduct. The interior of the aqueduct was thoroughly cleaned between April 10 and 15.

For considerable distances the fences built at the time of the construction of the aqueduct, having three 1-inch x 6-inch horizontal spruce rails, have become decayed, and 2,146 feet of this kind of fencing have been replaced by No. 65 Wheelock wire fence with chestnut posts, and 2,990 feet of the old fence have been repaired with material saved from the rebuilt portion.

The iron fences at the dams and highway crossings of the open channel, and the ironwork in the terminal chamber have been given one coat of Smith's Durable Metal Compound.

The town of Berlin has formally accepted the relocation of Crosby and Jones roads where they cross the aqueduct.

An area of about 1 acre along 1,200 feet of the aqueduct land immediately east of Bartlett Street in Northborough, and an area of 6 acres on the southerly side of the open channel in Marlborough, about ¼ of a mile below the terminal chamber, have been cleared of trees, which were cut into cord wood.

The weir at the terminal chamber, which has been used for measuring the flow through the aqueduct, was removed on September 25, and since that time the flow has been measured by means of four Venturi meters placed in the 48-inch outlet pipes at the Wachusett Dam.

The *Sudbury Aqueduct* was in use continuously throughout the year and delivered into Chestnut Hill Reservoir a daily average of 70,560,000 gallons, which was 14,473,000 gallons less than the daily average in 1910.

The joints in the granite masonry in the substructure of the waste-weir at Fuller's Brook and in the double culvert under the waste-weir were cut out and repointed, also the joints in the faces of the abutments at the top of Waban Bridge.

The high board fence crossing the aqueduct at the westerly end of Echo Bridge, the remains of fences which had been burned by grass fires on both sides of the aqueduct between Dover Street and Waban Bridge, and quite a number of unnecessary cross fences along the line of the aqueduct have been removed.

Fourteen alignment stones and 63 land bounds which were too low or out of position have been reset, and 13 bounds have been set at angle points where no bounds existed.

The heating plant formerly used in keeping the interior of the

Waban Bridge arches free from ice during the winter has been removed, as it has not been required since the lead lining was placed in the aqueduct.

The leakage at Echo Bridge, previously reported, increases from year to year, and the aqueduct at this bridge should be lined during the coming season.

Water was drawn through the *Cochituate Aqueduct* for the supply of the District on 210 days during the year, the total quantity drawn being 3,475,600,000 gallons, equivalent to a daily average of 9,522,000 gallons for the whole year.

The portion of the aqueduct between the Newton Centre waste-weir and the ventilator, a distance of 7,306 feet, was cleaned in June.

A small house which, for many years, has stood on the aqueduct land not far from Pleasant Street, in Newton, and an old barn on the T. V. Fitch estate, in Wellesley, a portion of which was on the aqueduct property, have been removed.

Chemical fertilizer has been placed on about half the area of the embankment slopes with satisfactory results.

A 6-inch water pipe has been laid across and over the aqueduct by the city of Newton on Waban Avenue opposite Nehoiden Road, and the town of Wellesley has laid a 6-inch water pipe across and over the aqueduct at Rice Street, Wellesley Hills. The city of Newton laid an 8-inch sewer over the aqueduct at the intersection of East and West Waban avenues, and a 6-inch sewer opposite the estate of E. E. Bessey on Beacon Street in Waban. These pipes were of cast-iron with leaded joints, for a distance of 24 feet on each side of the centre of the aqueduct.

The *Weston Aqueduct* was in continuous service between the Sudbury and Weston reservoirs throughout the year, with the exception of 1½ hours when the flow was stopped in order to examine gates and castings at the Sudbury Dam. The daily flow averaged 28,798,000 gallons until November 4, when the new 60-inch supply pipe line was placed in service, and 35,348,000 gallons after that date.

Rusted cable wire fencing has been replaced by No. 65 Wheelock wire fence for a distance of 1,644 feet in Weston between School Street and Connecticut Path, and 1,018 feet near the east end of tunnel No. 3.

Considerable work has been done in reseeding or planting with witch grass roots the aqueduct embankments between gaging chamber No. 2 and Elm Street, near siphon chambers Nos. 1 and 2 and west of School Street in Weston.

Chemical fertilizer has been spread on about half the area of the embankments along the line of the aqueduct.

PUMPING STATIONS.

Seventy-three per cent. of the water supplied to the Metropolitan District has been pumped at the two stations at Chestnut Hill Reservoir, and the remainder has been delivered by gravity. The total quantity pumped at all of the stations was 32,685,890,000 gallons, which was 4.17 per cent. less than during the preceding year.

The cost of operating the stations was $97,196.68, equivalent to $2.974 per million gallons pumped. The average cost of raising 1,000,000 gallons of water 1 foot high at all the stations was $0.0349, a slight increase above the cost in 1910.

Coal for use at the several stations has been purchased as follows: —

BY WHOM FURNISHED.	GROSS TONS.					Cost per Gross Ton, in Bins.[1]
	Chestnut Hill Pumping Station, No. 1.	Chestnut Hill Pumping Station, No. 2.	Spot Pond Station.	Arlington Station.	West Roxbury Station.	
Gorman-Leonard Coal Company, bituminous,	1,420.73	-	-	-	-	4.08
Gorman-Leonard Coal Company, bituminous,	199.89	-	-	-	-	4.03
Gorman-Leonard Coal Company, bituminous,	600.16	-	-	-	-	3.98
Gorman-Leonard Coal Company, bituminous,	-	1,797.60	-	-	-	3.95
New England Coal and Coke Company, bituminous.	-	257.61	-	-	-	3.94
Gorman-Leonard Coal Company, bituminous,	-	144.78	-	-	-	3.90
Madeira Hill Company, bituminous,	-	46.11	-	-	-	3.89
Gorman-Leonard Coal Company, bituminous,	-	1,778.27	-	-	-	3.86
Logan Coal Company, bituminous,	-	48.97	-	-	-	3.82
C. W. Claflin & Co., buckwheat anthracite,	540.30	-	-	-	-	2.88
C. W. Claflin & Co., buckwheat anthracite,	-	1,353.75	-	-	-	2.69

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[1] Includes cost of unloading coal from cars and all expenses incidental to storage of the coal.

By whom furnished.	Gross Tons.					Cost per Gross Ton, in Bins.[1]
	Chestnut Hill Pumping Station, No. 1.	Chestnut Hill Pumping Station, No. 2.	Spot Pond Station.	Arlington Station.	West Roxbury Station.	
New England Coal and Coke Company, bituminous.	-	-	114.62	-	-	4.91
New England Coal and Coke Company, bituminous.	-	-	488.24	-	-	4.35
Locke Coal Company, screenings,	-	-	446.87	-	-	2.50
Joseph Butler, screenings,	-	-	11.82	-	-	2.50
New England Coal and Coke Company, bituminous.	-	-	-	128.39	-	4.31
New England Coal and Coke Company, bituminous.	-	-	-	251.79	-	3.94
Philadelphia and Reading Coal and Iron Company, screenings.	-	-	-	91.00	-	2.72
Roxbury Coal Company, furnace,	-	-	-	-	6.22	5.88
Roxbury Coal Company, pea,	-	-	-	-	94.71	5.13
Roxbury Coal Company, buckwheat anthracite,	-	-	-	-	213.05	4.37
Total gross tons, bituminous,	2,220.78	4,073.34	602.86	380.18	-	-
Total gross tons, anthracite,	540.30[2]	1,353.75[2]	-	-	313.98	-
Total gross tons, anthracite screenings,	-	-	458.69	91.00	-	-
Average price per gross ton, bituminous,	4.03	3.90	4.46	4.06	-	-
Average price per gross ton, anthracite,	2.88[2]	2.69[2]	-	-	4.63	-
Average price per gross ton, anthracite screenings,	-	-	2.50	2.72	-	-

[1] Includes cost of unloading coal from cars and all expenses incidental to storage of the coal.
[2] Buckwheat.

The standard requirements in the contracts for the purchase of bituminous coal have been changed during the year for the purpose of improving the quality of the coal. The number of heat units required has been increased from 14,600 to 14,700, and the allowable percentage of ash has been decreased from 9 to 8.

The tests of the several kinds of coal burned at the Water Works stations indicate that the quality of the coal supplied during the past year has been higher than in previous years.

KIND OF COAL.	Number of Samples tested.	British Thermal Units.	Percentage of Volatile Matter.	Percentage of Ash.	Percentage of Moisture.
Beaver Run,	48	14,818	17.41	6.16	3.54
Sonman,	16	14,708	17.17	6.56	3.10
Pocahontas,	15	15,010	18.14	4.66	3.93
New River,	8	14,926	20.71	5.30	2.16
Vulcan,	4	14,890	20.53	5.79	2.32
Atlas,	2	14,906	20.38	5.65	3.56
Dunlo,	2	15,053	18.75	5.01	3.35
Spangler No. 4,	2	14,431	23.40	8.02	2.61
Logan,	1	14,783	17.83	6.64	3.69
South Fork,	1	14,730	18.08	6.69	3.93

CHESTNUT HILL PUMPING STATIONS.

In previous reports the two pumping stations at Chestnut Hill Reservoir have been designated as the Chestnut Hill High-service Pumping Station and the Chestnut Hill Low-service Pumping Station, for the reason that they contained engines used in pumping water consumed in the district designated by the title. During the past year an engine having a daily capacity of 40,000,000 gallons has been placed in the Low-service Station for use in supplying water to the high-service district. In this and subsequent reports the station which has been designated as the High-service Station will be designated as Chestnut Hill Pumping Station No. 1, and the station heretofore known as the Low-service Station will be known as Chestnut Hill Pumping Station No. 2. The following are statistics relating to operations at both of these stations: —

	Pumping Station No. 1.			Pumping Station No. 2.	Totals.
	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Engine No. 12.	
Daily pumping capacity (gallons),	16,000,000[1]	20,000,000	30,000,000	40,000,000	106,000,000
Total quantity pumped (million gallons),	671.54	(Not operated during the year.)	5,804.62	5,352.11	11,828.27
Daily average quantity pumped (gallons),	1,840,000		15,903,000	14,663,000	32,406,000
Coal used in pumping (pounds),	1,169,770		4,428,994	3,636,115	9,234,879
Gallons pumped per pound of coal,	574.08		1,310.60	1,476.99	1,280.83
Average lift (feet),	128.14		127.77	123.34	125.79
Cost of pumping: —					
Labor,	$1,988 57		$9,521 05	$8,576 99	$20,086 61
Fuel,	2,674 59		8,542 46	6,238 76	17,455 81
Repairs,	190 45		1,031 08	634 61	1,856 14
Oil, waste and packing,	81 09		461 13	168 04	710 26
Small supplies,	59 57		286 79	101 50	447 86
Totals,	$4,994 27		$19,842 51	$15,719 90	$40,556 68
Cost per million gallons pumped,	7.437		3.418	2.937	3.429
Cost per million gallons raised 1 foot high,	.0580		.0268	.0238	.0273

[1] 8,000,000 each.

	Chestnut Hill Pumping Station No. 2. — Engines Nos. 5, 6 and 7.
Daily pumping capacity each engine (gallons),	35,000,000
Total quantity pumped (gallons),	17,530,710,000
Daily average quantity pumped (gallons),	48,029,000
Total coal used (pounds),	6,597,460
Gallons pumped per pound of coal,	2,657.19
Average lift (feet),	46.34
Cost of pumping: —	
Labor,	$18,582 46
Fuel,	10,738 61
Repairs,	854 65
Oil, waste and packing,	362 02
Small supplies,	235 93
Total,	$30,773 67
Cost per million gallons pumped,	$1.7550
Cost per million gallons raised 1 foot high,	.0379

On account of irregularities in the operation of the engines pumping water for the southern high-service district, due to the installation of the new 40,000,000-gallon engine at Station No. 2, the cost per million gallons pumped to the reservoir by engines Nos. 1, 2 and 4 was somewhat larger than during the previous year.

A Uehling instrument for indicating and recording the percentage of carbonic acid CO_2 in the flue gases from the boilers, thus determining whether the fuel is being burned economically, was purchased and connected with the boilers in December. It is expected that the use of this instrument will result in a saving in the amount of coal used.

No expensive repairs have been made to the machinery in either of the stations.

Engine No. 12, although not yet tested and formally accepted, has been operated during a considerable portion of the year and has given a duty of between 150 and 160 million foot pounds per 100 pounds of coal.

The 48-inch and 60-inch pipes through which water is brought from the Chestnut Hill Reservoir into the pumping stations, together with the chambers in the gate-house at the reservoir, and the pump wells at Pumping Station No. 2, have been emptied and cleaned. The pipes were found to be coated with a heavy growth of Fredericella and Spongilla, a considerable portion of which dropped off the top and sides of the pipes when they were emptied and was washed out through the drain pipe. A considerable number of fresh water clams or mussels were found in the pipes and in the bottom of the gate-house. About 8 cubic yards of material were removed from 1,000 feet of 60-inch and 500 feet of 48-inch pipes. The sluice valves in the gate-house were cleaned and painted with red lead and oil.

The screen area in the gate-chamber has been increased from 167 square feet to 206 square feet, equivalent to 23 per cent., by substituting a screen for the stop-plank for a depth of 26 inches in each of the three passageways through which the water is drawn from the reservoir.

Spot Pond Pumping Station.

The following are statistics relating to operations at this station: —

Total quantity pumped (gallons),	2,770,220,000
Daily average quantity pumped (gallons),	7,590,000
Total coal used (pounds),	2,442,415
Gallons pumped per pound of coal,	1,134.21
Average lift (feet),	133.36
Engine No. 8 operated (hours),	72
Engine No. 9 operated (hours),	3,307
Quantity pumped by Engine No. 8 (gallons),	31,050,000
Quantity pumped by Engine No. 9 (gallons),	2,739,170,000

Cost of pumping: —	
Labor,	$8,516 68
Fuel,	4,153 76
Repairs,	187 17
Oil, waste and packing,	235 49
Small supplies,	189 93
Total for station,	$13,283 03
Cost per million gallons pumped,	$4.795
Cost per million gallons raised 1 foot high,	.0359

The quantity of water pumped was 0.66 per cent. greater, while the cost of operating the station was 2.49 per cent. less than in 1910.

ARLINGTON PUMPING STATION.

The following are statistics relating to operations at this station: —

Total quantity pumped (gallons),	304,820,000
Daily average quantity pumped (gallons),	835,000
Total coal used (pounds),	1,089,306
Gallons pumped per pound of coal,	279.83
Average lift (feet),	282.88
Engine No. 10 operated (hours),	5,989
Engine No. 11 operated (hours),	1,168
Quantity pumped by Engine No. 10 (gallons),	265,740,000
Quantity pumped by Engine No. 11 (gallons),	39,080,000

Cost of pumping: —	
Labor,	$4,694 92
Fuel,	1,836 00
Repairs,	299 36
Oil, waste and packing,	56 08
Small supplies,	292 20
Total for station,	$7,178 56
Cost per million gallons pumped,	$23.550
Cost per million gallons raised 1 foot high,	.0833

There was an increase of 7.89 per cent. in the quantity pumped and a decrease of 2.78 per cent. in the cost of operating the station as compared with the previous year.

The exterior woodwork of the building received a coat of paint early in December and the interior woodwork was being painted at the end of the year.

The side track, on which coal is delivered to the pumping station, has been repaired by the Boston & Maine Railroad at a cost of $110.46.

West Roxbury Pumping Station.

The following are statistics relating to operations at this station: —

Total quantity pumped (gallons),	251,870,000
Daily average quantity pumped (gallons),	690,000
Total coal used (pounds),	706,763
Gallons pumped per pound of coal,	356.37
Average lift (feet),	129.30
Engine No. 1 operated (hours),	236
Engine No. 2 operated (hours),	8,350
Engine No. 3 operated (hours),	246
Quantity pumped by Engine No. 1 (gallons),	6,360,000
Quantity pumped by Engine No. 2 (gallons),	232,900,000
Quantity pumped by Engine No. 3 (gallons),	12,610,000
Cost of pumping: —	
Labor,	$3,696 10
Fuel,	1,455 02
Repairs,	151 13
Oil, waste and packing,	42 03
Small supplies,	60 46
Total for station,	$5,404 74
Cost per million gallons pumped,	$21.459
Cost per million gallons raised 1 foot high,	.1660

The quantity pumped was 1.34 per cent. larger, while the cost of operating the station was 4.03 per cent. less than for the previous year.

CONSUMPTION OF WATER.

The daily average quantity of water consumed in the eighteen municipalities supplied from the Metropolitan Works during the year 1911, as measured by Venturi meters, was 109,994,800 gallons, equivalent to 105 gallons per capita in the district supplied. The daily average consumption was 2,097,300 gallons less than during the previous year, and 15,429,400 gallons less than during the year 1908. The per capita consumption has been reduced 18.6 per cent. in three years and is now as low as in 1898, when the Metropolitan Works were established.

The daily average quantity supplied to the Metropolitan Water District, as determined by pump measurement and by the flow in the Weston Aqueduct, and the estimated yield of Spot Pond was 110,456,000 gallons, equivalent to 105.5 gallons per inhabitant. The difference between the quantity delivered by the aqueducts and that measured by meters to the several municipalities is due to difference in the methods of measurement, to leakage from the Metropolitan Water Works reservoirs and pipes and to the use of water at the Chestnut Hill and Spot Pond pumping stations.

The daily average consumption of water in each of the cities and towns supplied from the Metropolitan Works during the years 1910 and 1911, as measured by meters, was as follows: —

	Estimated Population, 1911.	Daily Average Consumption.					
		1910.		1911.		Increase in Gallons.	Decrease in Gallons.
		Gallons.	Gallons per Capita.	Gallons.	Gallons per Capita.		
Boston, . . .	688,520	87,346,700	130	85,571,500	124	-	1,775,200
Somerville, . .	79,360	6,189,500	80	5,899,100	74	-	290,400
Malden, . . .	45,780	1,874,400	42	1,971,300	43	96,900	-
Chelsea, . . .	33,630	2,834,500	87	2,701,400	80	-	133,100
Everett, . . .	34,910	2,575,600	76	2,557,800	73	-	17,800
Quincy, . . .	33,760	2,891,900	88	2,925,400	87	33,500	-
Medford, . . .	24,100	1,422,400	61	1,207,100	50	-	215,300
Melrose, . . .	16,070	1,005,700	64	1,012,500	63	6,800	-
Revere, . . .	19,240	1,313,400	71	1,439,400	75	126,000	-
Watertown, . .	13,330	880,600	68	889,200	67	8,400	-
Arlington, . . .	11,700	938,200	83	983,200	84	45,000	-
Milton, . . .	8,140	309,200	39	317,700	39	8,500	-
Winthrop, . . .	10,670	649,500	63	597,800	56	-	51,700
Stoneham, . .	7,360	650,800	91	573,300	78	-	77,500
Belmont, . . .	5,840	329,500	59	415,500	71	86,000	-
Lexington, . .	4,590	345,500	78	352,900	77	7,400	-
Nahant, . . .	2,340	121,700	58	152,000	65	30,300	-
Swampscott, . .	7,290	412,800	59	427,700	59	14,900	-
District, . .	1,046,630	112,092,100	110	109,994,800	105	-	2,097,300

The consumption in the several districts was as follows: —

	Gallons per Day, 1911.	Decrease (Gallons per Day).	Percentage of Decrease.
Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston, .	45,420,600	753,000[1]	1.69[1]
Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston, ...	24,731,900	1,300,500	5.00
Southern high-service district, embracing the high-service districts of Boston, Quincy, Watertown, and portions of Belmont and Milton, ...	30,931,600	1,712,800	5.25
Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston, ...	7,385,500	92,900[1]	1.27[1]
Southern extra high-service district, embracing the higher portions of West Roxbury and Milton, ...	690,100	9,100[1]	1.34[1]
Northern extra high-service district, embracing Lexington and the higher portions of Arlington and Belmont, ...	835,100	61,000[1]	7.88[1]
Totals, ...	109,994,800	2,097,300	1.87

[1] Increase.

The diagram facing this page shows graphically the average daily consumption and the rate of consumption between the hours of 1 and 4 A.M. in the district supplied by the Metropolitan Works for each week during the years 1910 and 1911.

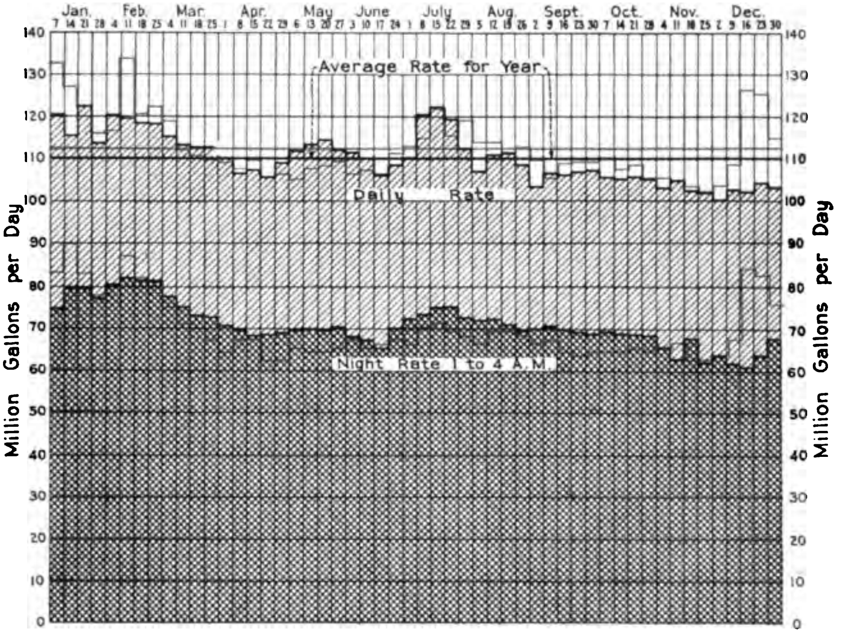
It will be noted that the low temperature during the months of January and December, 1910, as compared with the corresponding months in 1911, was coincident with a large increase in both the daily average and night rate of consumption. It is also noticeable that although the daily average was lower in 1911 than in 1910, the night rate has been larger during the greater portion of the past year than during the previous year. The fact that between the hours of 1 and 4 A.M. water is drawn from the mains at the rate of over 70,000,000 gallons in 24 hours is very strong proof that, notwithstanding the decrease in consumption, a large amount of preventable waste is still taking place.

Metering of Service Pipes.

The following table gives the statistics relative to the installation of water meters in the several cities and towns, in conformity with chapter 524 of the acts of 1907.

AVERAGE RATE OF CONSUMPTION IN METROPOLITAN WATER DISTRICT AND RAINFALL AND AVERAGE TEMPERATURE OF AIR AT CHESTNUT HILL RESERVOIR FOR EACH WEEK DURING 1911

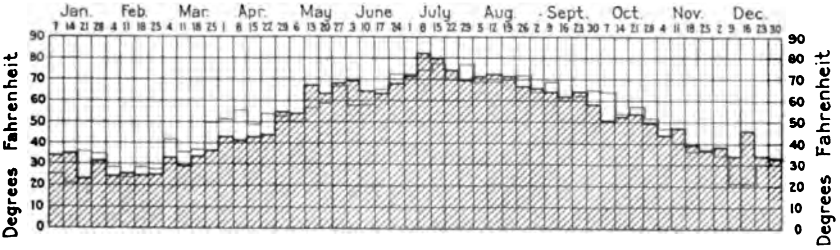
CONSUMPTION AND NIGHT RATE



RAINFALL IN INCHES

1.49	0.57	0.00	0.90	1.72	1.05	0.43	0.32	0.03	0.39	1.23	0.52	1.10	1.40	0.72	0.35	0.00	0.08	0.13	0.04	0.30	0.11	2.69	1.09	0.06	0.00	0.18	0.00	0.00	4.51	0.00	0.00	1.04	0.69	3.28	0.67	0.68	0.16	2.08	1.68	0.00	1.24	0.09	0.26	0.48	2.36	0.84	0.65	0.06	1.03	1.80	0.21

AVERAGE WEEKLY TEMPERATURE



Averages for 1910 shown in Red

UN 5 MIC

City or Town.	Number of Meters required to be set on Old Services Each Year.	Meters set on Old Services.				New Services installed, 1911.[1]	New Services equipped with Meters, 1911.[1]	Services in Use December 31, 1911.	Meters in Use December 31, 1911.	Per Cent. of Services metered December 31, 1911.
		1908.	1909.	1910.	1911.					
Boston, . .	4,225	84	5,503	5,481	6,487	1,441	1,078	95,037	25,975	27.33
Somerville, . .	411	732	621	501	570	137	200	12,259	6,526	53.23
Malden, . .	14	43	62	8	2	197	175	7,632	7,314	95.83
Chelsea, . .	240	198	756	779	1,092	80	80	4,510	4,252	94.28
Everett, . .	252	338	255	277	285	159	92	5.466	1,560	28.54
Quincy, . .	230	358	33	423	1,680	444	487	7,746	4,801	61.98
Medford, . .	179	857	927	1,555	178	175	175	4,563	4,542	100.00
Melrose, . .	119	2,432	135	7	5	37	82	3,620	3,863	100.00
Revere, . .	138	85	184	110	176	208	200	3,610	1,261	34.93
Watertown, .	-	-	-	-	-	114	60	2,156	2,130	100.00
Arlington, . .	55	108	56	63	127	141	121	2,181	1,536	70.43
Milton, . .	-	-	-	-	-	74	74	1,510	1,510	100.00
Winthrop, . .	100	213	975	706	6	84	95	2,553	2,487	100.00
Stoneham, . .	65	116	225	186	155	36	38	1,491	826	55.40
Belmont, . .	-	-	-	-	-	103	103	1,008	1,008	100.00
Lexington, . .	32	113	70	56	86	48	54	883	615	69.65
Nahant, . .	16	30	40	26	18	37	39	559	284	50.81
Swampscott, .	21	264	142	28	13	66	66	1,535	1,535	100.00
Totals, . .	6,097	5,971	9,984	10,206	10,880	3,581	3,219	158,319	72,025	45.49

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[1] The number of new meters installed and the number of new services equipped with meters seldom agree exactly for the reason that service pipes are installed but meters are not set until the buildings are permanently occupied.

All of the cities and towns in the District have set the number of meters required by the terms of the act, and nine municipalities had at the close of the year metered practically all of their service pipes. At the end of the year 45.49 per cent. of all the service pipes in the District were metered as compared with 37.56 per cent. at the beginning of the year.

WATER SUPPLIED OUTSIDE THE METROPOLITAN DISTRICT.

In addition to the quantity supplied to the cities and towns comprising the Metropolitan Water District, 1,260,625,200 gallons have been drawn from the Metropolitan Works for the supply of places outside the District, as follows: —

The United States Government Reservation on Peddock's Island has received a continuous supply equivalent to 89,300 gallons per day.

A small portion of the town of Saugus has been supplied with an average of 13,100 gallons per day through pipes of the town of Revere.

In consequence of the low level of the water in Crystal Lake, from which the town of Wakefield obtains its supply, 83,948,700 gallons were supplied to that town from the Metropolitan Works during the following periods: July 17 to 21 inclusive, August 10 to 17 inclusive, and August 22 to December 31 inclusive.

The town of Framingham has drawn 222,700,000 gallons from filter galleries located near Farm Pond on the Sudbury watershed, and 41,300,000 gallons from the Sudbury Aqueduct through a pipe crossing under Farm Pond.

For the use of the Westborough State Hospital, 53,053,000 gallons have been drawn from the open channel of the Wachusett Aqueduct. The supply to the hospital from this source was shut off from April 13 to May 18 inclusive, and on September 28 and 29, during which periods water was not flowing in the Wachusett Aqueduct.

The city of Worcester between August 1 and December 31 diverted 694,900,000 gallons from that portion of the Wachusett watershed which the city was in 1902 given the right to take for the purpose of a water supply; and between September 28 and October 21, the city diverted 64,900,000 gallons from the Wachusett watershed by pumping from Eagle Lake in Holden. Between October 24 and November 10, 62,440,000 gallons were drawn from the Wachusett Reservoir and pumped into the Worcester distributing mains.

The following table shows the quantities diverted and the amounts to be paid to the Metropolitan Water District for these quantities, with the exception of the sums to be paid on account of the diversion from Asnebumskit and Kendall Brooks and Eagle Lake, which have not yet been determined.

PLACE SUPPLIED.	Total Quantity (Gallons).	Average Daily Quantity (Gallons).	Dates on which Water was supplied.	Amounts charged for Water supplied.
Worcester: —				
From Eagle Lake,	64,900,000	177,800	Sept. 28 to Oct. 21,	. . .
From Asnebumskit Brook and Kendall Reservoir,	694,900,000	1,903,800	Aug. 1 to Dec. 31,	. . .
From Wachusett Reservoir,	62,440,000	171,100	Oct. 24 to Nov. 10, inc.,	$1,810 76
Westborough State Hospital,	53,053,000	145,300	Jan. 1 to Apr. 12, May 19 to Sept. 27, Sept. 30 to Dec. 31,	1,591 59
Framingham: —				
From Sudbury Aqueduct,	41,300,000	113,200	July 17,	991 20
From Farm Pond Galleries,	222,700,000	610,100		427 10
Wakefield,	83,948,700	230,000	July 6, July 17 to July 21, Aug. 10 to Aug. 17, Aug. 22 to Dec. 31,	5,876 40
Peddock's Island,	32,598,000	89,300	- -	2,036 32
Saugus,	4,785,500	13,100	- -	250 00
	1,260,625,200	3,453,700		

QUALITY OF THE WATER.

About forty per cent. of the water used in the Metropolitan District during the past year was drawn from the Sudbury and Cochituate sources. The proportion from these sources was much larger than in any year since 1898, and as a result the water drawn from the taps in the Metropolitan District has been of a higher color and has contained a larger proportion of ammonia and chlorine than in recent years.

The number of microscopic organisms present in the water has also been somewhat above the average, but there has been no growth of organisms of sufficient magnitude to cause objectionable tastes and odors in the water as drawn from the taps. Weekly microscopical and bacterial examinations have been made in the laboratory of the Board of the water from various parts of the works, and chemical examinations have been made by the State Board of Health, the results of which are given in tabular form in Appendix No. 2, Tables Nos. 28 to 34. There have been made 2,465 microscopical and 1,174 bacterial examinations of the water from various parts of the works, and results have been received of 397 chemical examinations made by the State Board of Health.

In the Wachusett Reservoir 195 units of Dinobryon were present in April, 140 units of Uroglena on May 1, 1,240 units of Anabæna on June 20, and 140 units of Uroglena on October 10. All of these growths were of short duration and not large enough to cause any trouble. The average color of the water was 0.08.

In the Sudbury Reservoir there was a growth of Synura from March 20 to May 1, with a maximum of 210 units on the latter date. Uroglena were present on May 8, but the growth lasted less than a week. There was a growth of Dinobryon during September and October which reached a maximum of 1,700 units in the latter part of September. None of these growths were of sufficient size to cause the water to have more than a very faint odor.

In Framingham Reservoir No. 3 Asterionella were present in March and April. On April 25, 5,780 units were observed. Chlamydomonas were present in small numbers from January 1 to the middle of May.

The waters of the Ashland and Hopkinton reservoirs have been of good quality and comparatively low in color. Hopkinton Reservoir contained a growth of about 500 units of Uroglena for two weeks in April.

Whitehall Reservoir contained a growth of Uroglena during April and a growth of Dinobryon during December, both of which caused the water to have a disagreeable taste and odor, but no water was being drawn from the reservoir during these periods.

There were no growths of objectionable organisms in Framingham Reservoir No. 2 during the year.

Growths of three objectionable organisms have been present in Lake Cochituate during the year. Chlamydomonas were present from January 1 until the middle of July, but did not affect the water drawn from near the surface after June 1. The largest number observed was 230 units on April 10. Dinobryon were observed in the latter part of July, but not in sufficient numbers to cause objectionable taste and odor until the early part of October, when 1,060 units caused the water to have a fishy odor when hot. This growth continued during October. During the period of summer stagnation a growth of Aphanizomenon developed at mid-depth in the lake, 11,520 units being observed on August 9. When the water in the lake overturned, in November, these organisms came to the surface and on reaching the consumers caused a few complaints to be received, not on account of the taste and odor, but because of a red scum which they caused on the hot water.

In the distributing reservoirs in the Metropolitan District there have been growths of Chlamydomonas, Dinobryon and Uroglena which have at times given a faint disagreeable odor to the water drawn from the taps, but the water has been generally of good quality and very few complaints have been received from the water takers.

A growth of Conferva, which attached itself to the bottom of the Bear Hill Reservoir, made its appearance in October and caused the water in that reservoir to have an objectionable appearance. The water was lowered about 4 feet and a portion of the growth removed.

The following table gives a comparison of the average results of the examinations of water from a tap in Boston for the years 1902 to 1911, inclusive: —

	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.
State Board of Health Examinations.										
Color (Nessler standard), .	0.26	0.25	0.23[1]	0.24[1]	0.24[1]	0.22[1]	0.19[1]	0.18[1]	0.14[1]	0.25[1]
Total residue, . . .	3.93	3.98	3.93	3.86	3.86	3.83	3.50	3.46	3.05	4.18
Loss on ignition, . . .	1.56	1.50	1.59	1.59	1.39	1.40	1.35	1.43	1.24	1.66
Free ammonia, . . .	0.0016	0.0013	0.0023	0.0020	0.0018	0.0013	0.0011	0.0011	0.0013	0.0015
Albuminoid ammonia, total, .	0.0139	0.0125	0.0139	0.0145	0.0159	0.0129	0.0115	0.0128	0.0118	0.0156
Albuminoid ammonia, dissolved, .	0.0119	0.0110	0.0121	0.0124	0.0134	0.0109	0.0092	0.0103	0.0102	0.0128
Albuminoid ammonia, suspended, .	0.0020	0.0015	0.0018	0.0021	0.0025	0.0020	0.0024	0.0025	0.0016	0.0029
Chlorine, ...	0.29	0.30	0.34	0.35	0.34	0.33	0.33	0.28	0.28	0.38
Nitrogen as nitrates, . .	0.0092	0.0142	0.0110	0.0083	0.0054	0.0068	0.0092	0.0034	0.0030	0.0029
Nitrogen as nitrites, . .	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
Oxygen consumed, . .	0.40	0.39	0.37	0.35	0.36	0.32	0.26	0.25	0.22	0.33
Hardness, ...	1.3	1.5	1.5	1.4	1.3	1.3	1.2	1.3	1.1	1.4
Metropolitan Water and Sewerage Board Examinations.										
Color (platinum standard), .	.33	.35	.32	.28	.25	.27	.22	.23	.18	.23
Turbidity.	2.3	2.2	2.4	1.9	2.2	2.2	2.4	2.6	2.1	2.2
Total organisms, . . .	367	286	303	528	550	427	695	1,959	421	735
Amorphous matter, . .	34	36	36	37	42	47	64	97	72	76
Bacteria, ...	164	126	176	231	154	176	148	195	213	197

NOTE. — Chemical analyses are in parts per 100,000, organisms and amorphous matter in standard units per cubic centimeter, and bacteria in number per cubic centimeter. The standard unit has an area of 400 square microns, and by its use the number of diatomaceæ are decreased, and the number of chlorophyceæ and cyanophyceæ are very much increased, as compared with the number of organisms.

[1] Platinum standard.

SANITARY INSPECTION.

All premises on the several watersheds have been inspected for the purpose of maintaining sanitary conditions that will protect from pollution the water supplied to the Metropolitan District. The results of these inspections are given in the following tables: —

Summary of Sanitary Inspections on the Wachusett Watershed in 1911.

DISTRICT.	Number of Premises inspected.[1]	CLASSIFICATION OF CASES INSPECTED.													CONDITION AT END OF YEAR.		WATER SUPPLY.		
		Cesspools dug before 1911.	Cesspools dug during 1911.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	INDIRECT SINK DRAINAGE.		BARN DRAINAGE.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter Beds.	Satisfactory.	Unsatisfactory.	Premises having Public Water Supply.	Premises supplied by Private Wells, Cisterns, etc.	Premises on which no Water is used.
							Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.									
French Brook,	61	27	3	-	-	-	25	2	27	1	-	4	2	-	58	3	8	51	2
Muddy Brook,	37	13	1	-	-	-	19	-	22	-	-	-	-	1	37	-	-	37	-
Gates Brook,	167	103	5	-	2	-	39	3	50	-	-	10	1	-	163	4	-	162	5
Malden Brook,	29	14	-	-	-	-	15	-	22	-	-	1	1	-	29	-	-	28	1
Chaffin Brook,	186	89	4	-	1	-	70	8	87	-	-	14	2	-	178	8	71	108	7
Asnebumskit Brook,	281[2]	137	10	3	3	9	59	8	85	-	3	39	7	2	261	20	185	80	16
Muschopauge,	88	22	-	-	1	1	48	2	42	1	-	10	1	-	84	4	5	78	5
South Wachusett Brook,	86	32	1	1	1	1	40	3	49	1	-	8	3	-	81	5	-	82	4
Trout Brook,	34	4	-	-	-	-	25	1	26	-	1	2	-	-	32	2	-	33	1
East Wachusett Brook,	207	80	-	2	-	3	107	5	105	3	-	14	2	1	195	12	-	197	10
Stillwater River,	142	53	-	-	-	-	75	2	75	2	-	8	3	1	139	3	-	136	6
Waushacum,	166[3]	64	1	-	-	1	88	3	60	2	-	7	6	82	161	5	-	160	6
French Hill,	31	19	1	-	-	-	9	-	12	-	-	1	1	-	31	-	-	30	1
Totals,	1,515	657	26	6	8	15	619	37	662	10	4	118	29	87	1,449	66	269	1,182	64

[1] On some premises there are two or more cases.

[2] Not including 11 summer cottages at Asnebumskit Pond.

[3] Not including 213 summer cottages at Waushacum Lakes.

Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in 1911.

DISTRICT.	Number of Premises inspected.[1]	CLASSIFICATION OF CASES INSPECTED.														CONDITION AT END OF YEAR.	
		Sewer Connections.	Cesspools dug before 1911.	Cesspools dug during 1911.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Sink Drainage.	INDIRECT SINK DRAINAGE.		BARN DRAINAGE.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter-beds.	Satisfactory.	Unsatisfactory.
								Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.						
Sudbury Watershed.																	
Farm Pond,	280	259	10	3	-	1	-	-	-	17	-	-	5	7	-	279	1
Framingham Reservoir No. 3,	89	-	43	3	-	1	-	33	4	42	-	-	2	2	-	85	4
Stony Brook,	296	-	219	4	-	-	-	37	4	114	5	-	18	12	1	288	8
Anglo Brook,	1,980	1,537	286	1	-	1	2	104	3	226	1	1	49	16	1,786	1,976	4
Framingham Reservoirs Nos. 1 and 2, and Cold Spring Brook,	312	-	180	7	-	-	-	95	2	97	-	-	19	6	-	310	2
Eastern Sudbury,	222	-	168	17	-	-	-	28	4	36	-	1	5	11	-	217	5
Indian Brook,	412	-	199	2	-	-	4	146	14	73	2	-	27	14	-	393	19
Western Sudbury,	184	-	87	-	-	1	-	66	11	67	-	1	7	9	-	172	12
Whitehall Reservoir,	113	-	29	-	-	1	-	63	2	37	-	-	11	5	-	111	2
Cedar Swamp,	800	518	170	1	-	1	-	56	21	133	-	-	38	14	-	779	21
Cochituate Watershed.																	
Snake Brook,	184	-	125	-	-	1	-	44	4	43	1	-	5	4	-	180	4
Pegan Brook,	983	685	219	9	-	-	2	48	-	93	-	1	4	10	945	983	-
Course Brook,	89	2	59	3	-	1	-	18	2	43	-	-	3	2	-	87	2
Beaver Dam Brook,	1,291	941	213	33	2	12	4	46	18	157	10	1	31	18	-	1,262	29
Totals,	7,235	3,942	2,007	83	2	20	12	784	89	1,178	19	5	224	130	2,732	7,122	113

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[1] On some premises there are two or more cases.

Under the heading "unsatisfactory" are included all cases where it is possible that under the most unfavorable conditions drainage from privies or sinks may reach a water course, all suspected cases and all cases of manufacturing wastes entering feeders, even though there may have been some attempt at previous purification.

The drainage system constructed during 1910 for the purpose of diverting from Lake Cochituate the surface drainage from an area of about 140 acres, on which there was in 1910 a resident population of 707, was placed in service on January 13, 1911, thus removing several cases of unsanitary drainage.

During the past year there has been a large growth in the industrial development of South Framingham, which has increased the growth of population, not only in that village but also in the adjoining towns of Natick, Sherborn, Ashland and Hopkinton. In South Framingham, 4 factories, 2 stores, 1 hall and buildings for the occupancy of 156 families have been erected and several more are under construction.

This building development has extended beyond the reach of the present sewer system in Framingham, and in some cases the new buildings are in locations where the sewage cannot be disposed of in cesspools without endangering the water supply. In the Lokerville section there are 140 houses from which the drainage cannot be taken into the existing sewer system, and at a recent town meeting the Sewer Commissioners of Framingham were instructed to make a study of the problem of providing sewerage for this area, as well as for the area near the State Muster Field, known locally as Hastingsville. It is desirable that sewers should be provided in this section in order to prevent the pollution of the Metropolitan Supply.

During the past year a public water supply has been introduced in the town of Ashland. The supply is drawn from driven wells located near the Sudbury River, above the Dwight mill pond, and is pumped to a concrete standpipe built on a hill off Myrtle Street. The water is distributed through 6.5 miles of 6-inch, 8-inch and 12-inch pipe to 224 houses. Although the soil throughout the village is generally gravelly, it is probable that the increased use of water in the town will tend to increase the danger of polluting the water of Framingham Reservoir No. 2.

The New York, New Haven & Hartford Railroad Co. has maintained a camp for laborers on the shores of Farm Pond, and early in the year complaints were made that the conditions at the camp were not sanitary. Although the water from Farm Pond has not been used for the supply of the Metropolitan District for many years, the Railroad Company, at our request, dug a cesspool, cut and burned brush and trimmed trees in the vicinity of the camp, and stationed a watchman there to enforce sanitary regulations.

In the cities and towns on the Sudbury and Cochituate watersheds, which have systems of sewerage conveying the sewage outside the watersheds, the number of premises connected with sewers has been increased by 132, and the number existing on streets where sewers have been built has been reduced from 150 to 127. The number in the several places on December 31, 1911, was as follows: —

	Premises connected with Sewers.		Premises not connected with Sewers.	
	1910.	1911.	1910.	1911.
Marlborough,	1,522	1,537	83	71
Westborough,	510	518	25	19
Framingham,	1,116	1,197	9	5
Natick,	656	685	33	32
Sherborn,	6	5	-	-
Totals,	3,810	3,942	150	127

Nine cases of typhoid fever were reported from the Wachusett watershed, 7 of which were in Holden and 2 in Princeton. Four of the Holden cases were from one family in January, and the others occurred in May, September and October, in Holden Centre, Bryantville and Dawson. The 2 cases in Princeton were at Buck's Mill in August, and were closely connected. Thirty-three cases were reported on the Sudbury and Cochituate watersheds, 18 of which occurred in houses connected with the public sewers which convey house drainage outside the watershed. Ten of the cases were reported from Natick, 1 from Wayland, 11 from Framingham, 2 from Ashland, 2 from Southborough, 6 from Marlborough and 1 from Westborough. Seven of the cases in Natick were apparently caused by an infected milk supply. Four of the cases in Framingham occurred in one house, just at the close of the year. In all cases the premises were visited and precautions taken to prevent the spread of the disease or the pollution of the water supply.

Swamp Ditches and Brooks.

The ditches draining swamps on the several watersheds, having an aggregate length of 36.36 miles, have been cleaned as usual and the weeds and brush mowed and burned for a width of from 10 to 20 feet on both sides of the ditches. Ditches in Crane Swamp, in Marlborough and Northborough, and in Swamp No. 76, in Sterling, were repaired for a length of 1.78 miles where the side slopes had been injured by cattle. The wire fencing on the property line around Big Crane Swamp was repaired for a distance of 7,000 feet by setting new chestnut posts and restringing the wires, and new Wheelock wire fence 844 feet long erected on the property line between land of the Board and J. A. McHale on the westerly side of the Big Crane Swamp.

Observations have been made of the colors of the waters of the brooks draining the swamps which have been improved by ditching as follows: —

SWAMP.	Area of Watershed (Acres).	Area of Swamp (Acres).	Length of Ditches (Feet).	COLORS OF WATERS (PLATINUM STANDARD).						
				BEFORE DRAINING.		AFTER DRAINING.				
				Averages for Years 1894, 1895, 1899.	Averages for Years 1900, 1901, 1902.	1907.	1908.	1909.	1910.	1911.
Crane, . .	1,856	460	45,250	1.95	-	.77	.72	.64	.65	.60
No. 54, . .	750	72	8,930	-	.90	.53	.41	.33	.36	.44
No. 55, . .	1,625	220	27,661	-	1.27	.80[1]	.44	.36	.38	.47
No. 76, . .	225	26	6,173	-	.44	.27	.24	.20	.21	.29

[1] Nearly one-half of the ditches in Swamp No. 55 were not built until 1907.

Protection of the Supply by Filtration.

The filter-beds which are maintained for the purpose of purifying the surface water collected from thickly populated districts before its admission to the storage reservoirs have been cared for as usual.

The filter-beds, having an area of 14 acres, which receive and filter the water from about 1.8 square miles of the thickly settled portion of the city of Marlborough, received and cared for the entire flow of the brook during the year. The 17 artificial beds were cleaned in June and again in September and October; the 8 natural beds were thoroughly cleaned in June and the weeds were cut in September and October.

The reservoir and filter-bed on Farm Street, in Framingham, received diluted sewage from the overflow of the Marlborough main sewer on two days in March, two days in April and one day in December, and there was a flow of ground water upon the bed at times during March, April, May, November and December.

At the Pegan Brook pumping station, where the surface drainage from an area of about 1 square mile in the thickly settled portion of Natick is pumped upon filter-beds before entering Lake Cochituate, the pumps were operated 193 days during the year and 220,939,000 gallons were pumped, equivalent to a daily average of 605,310 gallons. The quantity of coal used was 152,230 pounds and 1,451 gallons were pumped per pound of coal. The cost of operating the pumping station, cleaning the filter-beds and caring for the grounds was $2,731.18, making the cost per million gallons filtered $12.36.

The water flowing from an area of 225 acres, in which is included the more thickly settled portion of the town of Sterling, has been filtered on 4 filter-beds, having an area of 2 acres, before entering Waushacum Pond on the Wachusett watershed.

The Gates Terrace filter-beds, at Sterling Junction, on which is received the drainage from a few summer cottages, were operated from April 22 to October 31.

The filter-beds on which is received the drainage from the Worcester County Training School have received the usual attention and have satisfactorily cared for the sewage of that institution.

FORESTRY.

During the past year trees and shrubs have been planted as follows: —

On the Wachusett watershed 30 acres of land on shallow flowage fills, in drained swamps and intervale lands were planted with 12-inch to 24-inch arbor vitæ seedlings spaced 6 feet apart in both directions, and 12.5 acres of land east of the South Dike in Clinton, where pines planted in 1908 had been destroyed by fire, were replanted with 3-year-old pine seedlings. The area occupied by the Flagg nursery and by nearly all of the Lamson nursery has also been planted with white pines.

Three thousand white pines were set out along the line of the Weston Aqueduct, at Edgell Street near the Nobscot Station, near gaging-chamber No. 2 and near siphon-chamber No. 2.

The necessary care has been given to the Lamson and Oakdale nurseries. At the close of the year the Lamson nursery contained 2,200 arbor vitæ seedlings from 12 inches to 18 inches high, and the Oakdale nursery, which was started in 1910, contained 2,000 2-year-old white pine transplants, 22,800 2-year-old white pine seedlings and 28,700 1-year-old white pine seedlings.

On the Wachusett watershed the undesirable trees and brush have been cut on 55 acres of land planted with pines, and an improvement thinning has been made on 55 acres of land on which there is a growth of trees from 20 to 40 years old. The gross cost of the work on both of these areas was $2,362.31, but as $983.61 were received for fence posts, railroad ties and cordwood sold, the net cost of the improvement was $1,378.70.

Exclusive of the lands submerged by the Wachusett Reservoir, the Board now owns about 4,500 acres of land on the Wachusett watershed. of which about 1,800 acres were forested when acquired, 1,350 acres have been planted, 520 acres remain to be planted and 830 acres are not available for planting.

The protection of the trees from the ravages of destructive insects has necessitated the expenditure of $7,062.21, as follows: —

Spot Pond,	$2,954 40
Mystic Lake,	46 24
Chestnut Hill Reservoir,	655 89
Weston Reservoir and Aqueduct,	1,178 18
Sudbury and Cochituate Aqueducts,	275 58
Lake Cochituate,	131 00
Sudbury Reservoir,	149 98
Framingham Reservoirs, Nos. 1, 2 and 3,	30 00
Wachusett Reservoir and Aqueduct,	1,640 94
	$7,062 21

In addition to the above, $1,266.50 was expended for the purchase from the Fitzhenry-Guptill Company of a power sprayer consisting of a U-shaped tank, having a capacity of 400 gallons, a 4-cylinder, 4-cycle, 10-horse-power gasoline engine, and a 3½-inch x 3¾-inch phosphor bronze triplex pump, all mounted on a platform wagon.

The work of spraying is done with this machine much more efficiently and economically than by the method previously used, in which the power was furnished by tanks of gas under high pressure.

At Spot Pond 55 acres were sprayed between May 26 and June 3, using 1,840 pounds of arsenate of lead. About 950 pounds of tanglefoot and 69 gallons of creosote mixture were also used on the trees.

At the Weston Reservoir and along the Weston Aqueduct about 24 acres were sprayed. Work at this reservoir was much increased for the reason that the adjacent property owners have done but little to suppress the moths.

The number of both brown-tail and gypsy moths on the land controlled by the Board has increased, particularly in the vicinity of the Sudbury and Wachusett reservoirs, where the area of woodland is large. The oak trees in the vicinity of the North Dike at the Wachusett Reservoir are badly infested with brown-tail moths, and 71 acres of this land were sprayed with arsenate of lead. All of the young pines on both the Sudbury and Wachusett works have been inspected twice during the year, and shoots infested with the pine-tree weevil have been cut off and burned. The number of infested shoots was less than during the previous year.

Late in the year it was discovered that chestnut trees near the Wachusett Dam were infected with the Chestnut Bark Disease, which has destroyed all or nearly all of this species of tree on a large area in New Jersey, Pennsylvania and New York. Trees affected by this disease have been found in the towns of Marlborough, Northborough, Clinton, Boylston, Sterling, West Boylston and Holden, and it is feared that it may be necessary to cut all chestnut trees on the property of the Board.

One result of the severe drought during the spring months was a large number of forest fires on the watersheds, several of which caused much damage to the tree growth. The most serious fire occurred on May 10 and burned over 211 acres belonging to the

Board, 103 acres of which were pasture land; 59 acres were covered with a growth of 10 and 12 year old white pine seedlings and 49 acres with hard wood timber from 15 to 40 years old. This fire was caused by a spark from a locomotive on the Boston & Maine Railroad and the Railroad Company reimbursed the Board for the damage to the amount of $3,000.

The total number of fires reported on the Wachusett watershed was 21 and the area burned over 330 acres. The total estimated damage was $3,985.78, and the amount received from railroad companies in reimbursements for fires caused by locomotives was $3,136.90. The number of pine trees destroyed by the fires was about 47,000. Seven fires occurred on the Sudbury Works, burning over 45⅓ acres, but most of the fires occurred on pasture land and the loss was not large.

Seven fires occurred on the grounds at Spot Pond, burning over 11.34 acres and destroying 250 small white pines.

From January 1 until February 11 about 6 men were employed cutting into cordwood the trees in Crane Swamp which were felled by fires which occurred in September and October, 1910. Two hundred and eleven cords of wood were cut and this, with the remaining standing wood on 105 acres, most of which was killed by the fire, was sold to E. W. Wheeler & Son of Berlin, Mass., for $1,367.50.

Distributing Reservoirs.

Weston Reservoir.

The reservoir and its connected structures are in good order. In addition to the regular work of caring for the grounds and buildings, cleaning the screens and open channel, painting fences and tool houses and destroying moths, the attendant and three men employed at the reservoir have constructed a footpath alongside the aqueduct from Newton Street to the screen-chamber, a distance of 1,550 feet.

Chestnut Hill Reservoir.

The grounds and structures are in good condition, with the exception of the wooden fence on the line of Beacon Street, which should be replaced during the coming year. The exterior woodwork of the upper, intermediate and lower gate-houses has been given two coats of paint. Considerable time has been spent in removing water grasses from the shallow parts of the reservoir, especially from the Lawrence Basin, where the growth appears to increase from year to year.

Waban Hill Reservoir.

The exterior and interior woodwork of the gate-house has received two coats of paint and the embankments were given a dressing of stable manure.

Forbes Hill Reservoir and Standpipe.

The standpipe was in service throughout the year except from September 13 to October 14, while the upper floor of the tower was being renewed. The granolithic surface of the upper floor, which had become badly cracked, was removed, together with the underlying cinder concrete which was disintegrated. The granolithic was broken into pieces about 1 inch in diameter and then mixed with small stones and so used as a foundation on which was placed a layer of felt covered with a 2-inch layer of Portland cement concrete mixed in the proportion of 1 part of cement, 2 of sand and 4 of pebbles. Upon this foundation, which was prepared by the maintenance department, the Simpson Brothers Corporation placed a layer of Neuchatel rock asphalt 1 inch in thickness, reinforced with corrugated steel. A 6-inch fillet of asphalt was placed next the outer wall of the tower. The cost of the work was $718.83. The granolithic walk around the reservoir has been repaired by relaying four of the concrete blocks and by digging out and grouting the smaller cracks. Some repairs were made to the concrete lining of the reservoir.

Mystic Reservoir.

This reservoir has been in continuous use throughout the year.

Mystic Lake and Pumping Station.

Mystic Lake has not been used as a source of water supply since January 1, 1898, and the machinery at the pumping station has not been operated since that date. The house occupied by the Superintendent of Pipe Lines and Reservoirs, which is located near the pumping station building, together with the barn and stable on the same grounds, have received two coats of paint and minor repairs. A new floor has been laid on the bridge over the outlet at the Lake.

Arlington Standpipe.

The standpipe was out of service from November 15 to December 14, during which time it was cleaned, the exterior given two coats of white lead and oil, and the interior one coat of red lead and two coats of Gilsonite paint. The work was done by F. A. Tibbetts, of Malden, at a cost of $475.

Spot Pond.

A foreman and 8 men have cared for the grounds and buildings around the pond, cleaned the shores, resurfaced the paths and patrolled the grounds for the purpose of protecting the property of the Board and preventing the pollution of the water.

Fells and Bear Hill Reservoirs.

These reservoirs have been in service throughout the year.

PIPE YARDS.

At both the Chestnut Hill and Glenwood pipe yards the buildings are in good condition. The railroad siding at the Glenwood pipe yard has been repaired at a cost of $113.75, and that at the Chestnut Hill yard at a cost of $220.68. Concrete bins, having a capacity of about 70 cubic yards, have been built at the Glenwood yard for the storage of sand and stone used in repairing streets. A watchman's clock with five stations has been installed at the Glenwood yard.

PIPE LINES.

The length of pipes owned and operated by the Metropolitan Water and Sewerage Board was increased by 4.56 miles during the year, making a total on December 31, 1911, of 101.58 miles. The length of mains 4 inches in diameter and larger connected with the works but owned and operated by the several cities and towns supplied with water, is 1,569.92 miles.

The most important work done during the past year in connection with the maintenance of the pipe lines has been the changes made necessary by the abolishment of the crossing at grade of Webster Avenue and the Fitchburg Railroad in Somerville. This work necessitated the raising of 983 feet of 48-inch pipe and the laying of 256 feet of 48-inch pipe on a temporary timber foundation and on a bridge over the railroad. The method adopted for raising the pipes was as follows: — Spruce piles were driven on each side of the pipe at intervals of 6 feet, and alternate bents of the piles were capped with 6-inch x 12-inch girder caps set at the elevation of the surface of the regraded street. The pipes were raised by the use of screws 2½ inches in diameter and 6 feet long, suspended from the girder caps and connected with the pipes by means of wire ropes and chains. After the pipes were raised to the required height they were supported on 12-inch x 12-inch caps placed at intervals of 6 feet for the whole length of the raised portion of the main. The pipes were raised about 17 feet at the crossing of the railroad, where the pipes are now supported on a bridge located alongside and east of the roadway bridge. The pipe bridge consists of two plate girders 78 feet long, 6 feet high, placed 11 feet apart, with a wooden floor and cover forming a box in which are laid the Metropolitan Water Works 48-inch main and the 20-inch main of the city of Somerville. In connection with this work it was necessary to relocate a 36-inch valve and a 20-inch connection with the Somerville pipe system, on which there was a Venturi meter. The work was begun in May, the 48-inch main was cut and emptied preparatory to being raised on June 13, and the main was again placed in service on July 8.

The cost of the work has been paid by the Boston & Maine Railroad in connection with other charges for the abolishment of the grade crossing, and the necessary excavation, together with the construction of the trestle and pipe bridge, was done by the contractors for the Railroad Company. The Metropolitan Water Works furnished the pipe, superintended the work and supplied the skilled labor required for raising and relocating the pipes. The cost of pipes and special castings furnished by this department was $2,259.25 and of labor and other expenses $4,250.01. The total cost of the work connected with the raising and relocation of the pipe, including the portion of the work done by the Railroad Company, was $15,616.42.

Between November, 1910, and March, 1911, a new and enlarged channel for Stony Brook was constructed at Morton Street, in West Roxbury. For the permanent support of the 36-inch water main which crosses over the channel at this point three masonry piers, spaced 17 feet on centres, were built up from the conduit and the pipes are now supported on hard pine blocks placed on top of these piers.

There have been 43 leaks on the Metropolitan water mains, none of which have been of a serious character or have caused damage to private property by flooding. Thirty-six of the leaks were due to defective joints and 14 of these occurred at wooden joints, which have been used in place of lead to prevent electrolytic action on the pipes. The total cost of repairing all leaks was $1,528.90, of which amount $708.57 was incurred in repairing two leaks at joints on pipes under the Mystic and Malden rivers, where the services of a diver were required.

A 48-inch pipe in the line which is used in conveying water from the Chestnut Hill Reservoir to the wells in the pumping stations was found to be cracked for its entire length, due to settlement of the pipe until at one point it rested on a boulder. The leakage from this break was very small as there was but little pressure on the pipe. The cost of substituting a new pipe was $191.76.

The steelwork of the bridge which supports the 20-inch water main over the Boston & Albany Railroad at St. James Street, in Newton, has been scraped, the bare spots given a coat of red lead, and all the steelwork given one coat of Smith's Durable Metal Compound. The woodwork of the bridge was given one coat of white lead and oil. The cost of this work was $134.35.

The bridge which supports the 48-inch and 20-inch pipes over the Boston & Maine Railroad at College Avenue, in Medford, has been treated in the same manner. Sheet lead was also placed under the steel girders where they are exposed to the blast of gases from locomotives. The cost of repairing this bridge was $384.84.

The upper surface of the roof or cover of the bridge which supports the 48-inch and 20-inch mains over the Mystic River in Medford, is used as a foot path by the public, and the wood surface, which was worn, has been replaced by a layer of Neuchatel asphalt about 1 inch in thickness.

METERING OF WATER TO MUNICIPALITIES.

There were 65 Venturi meters, in sizes varying from 6 inches to 60 inches, connected with the Metropolitan water mains on December 31, 1911, of which 52 were in use in measuring the water supplied to the several municipalities in the Metropolitan District. There were also 4 Hersey disc meters, 1 Hersey torrent, 3 Hersey detector, 2 Crown and 3 Union rotary meters, which were used to measure the water supplied in districts where the flow was too small to be conveniently or properly measured with a Venturi meter. All of these meters have been read and inspected twice each week, and all necessary repairs made by a regular force of two men with an occasional assistant. The interior surfaces of the steel chambers in which the meters are placed have been scraped and painted.

Pressure Regulators and Recording Gages.

No change has been made during the year in the number or location of the pressure regulators used to control the pressure in the mains in the District. The 19 pressure recording gages connected with the distribution system have been in constant use and the average elevations of the water, due to the pressure in the mains, is given in Appendix No. 2, Table No. 44.

Electrolysis.

A complete electrical survey of the Metropolitan water mains was made during January, February and March, to determine the difference of potential between the pipes and electric railway tracks and the electric currents flowing over the pipes. At several places the conditions shown by the survey differed from the conditions determined from the previous complete survey, made during the summer of 1908; and in general, while the differences of potential have increased somewhat, the current flows have decreased, which would seem to indicate a higher soil resistance during the winter of 1911 than during the summer of 1908. The results also show that the installation of wooden insulating joints on our pipe lines constructed since 1908 has prevented an increase in the electric currents flowing on the pipe system, which would otherwise have resulted from the construction of the new mains.

Features which seem to require special consideration are: The development of a large positive area on the low service pipe lines near Coolidge Corner in Brookline, due to the operation of a new sub-station on Webster Street since the middle of November; the development of a small positive area in the vicinity of Salem Street and Fellsway West, in Medford, which has gradually been developing since the power station was put in operation at this place in August, 1906; an increase in the positive area near Washington Square in Chelsea; a very large increase in the negative potential at Boylston Street near Chestnut Hill Avenue in Brookline; and a noticeable increase in negative potentials and electric currents on the supply pipe lines in Newton.

The electrical conditions on the remainder of the system are substantially the same as have existed for the past few years.

CLINTON SEWERAGE.

Pumping Station.

The Clinton sewage-disposal works were operated daily throughout the year. The average daily quantity of sewage pumped to the filter-beds was 829,000 gallons. The sewerage system of the town was extended quite materially during the year, but there was no increase in the quantity of sewage, due probably to the low rainfall.

The following are statistics relating to the operation of the pumping station: —

Daily average quantity of sewage pumped (gallons),	829,000
Daily average quantity of coal consumed (pounds),	1,380
Gallons pumped per pound of coal,	600
Number of days pumping,	365
Cost of pumping: —	
Labor,	$1,715 34
Fuel,	1,104 88
Repairs and supplies,	194 63
Total for station,	$3,014 85
Cost per million gallons pumped,	$9 97
Cost per million gallons raised 1 foot high,	0.201

About ¾ of an acre of land, comprising lawns and grass land about the pumping station was graded and seeded down in the spring.

Filter-beds.

The sewage was applied to the filter-beds in practically the same manner as during the preceding 3½ years. The beds were used in rotation throughout the year. Each of the 25 one-acre beds has received about 59,600 gallons of sewage in 30 minutes about once in two days.

The sludge collected in the 8 settling basins, amounting to 724 cubic yards, has been used on grass lands belonging to the Board at the filter-beds and on the rear slope of the westerly portion of the North Dike.

The results of the analysis of the sewage and effluent are given in the following table: —

[Parts per 100,000.]

	1906.	1907.	1908.	1909.	Average of Four Years, 1906–09.	1910.	1911.
Albuminoid ammonia, sewage, .	.8558	.8442	.5735	.7425	.754	.7050	1.0683
Albuminoid ammonia, effluent, .	.0955	.0744	.0554	.0819	.0768	.0686	.0639
Per cent. removed, ...	89	91	90	89	89.7	90.3	94
Oxygen consumed, sewage, . .	9.84	7.87	3.43	7.04	7.045	6.658	9.3292
Oxygen consumed, effluent, . .	1.34	1.07	0.765	1.165	1.085	.8863	.8713
Per cent. removed, ...	86	87	78	83	83.5	86.7	91
Free ammonia, sewage, . . .	3.5650	3.8342	4.6193	4.6283	4.1617	3.8867	5.7417
Free ammonia, effluent, . . .	1.2723	1.3176	1.3722	1.2917	1.3134	.6493	.7369
Per cent. removed, ...	64	66	70	70	67.5	83.3	87
Nitrogen as nitrates, effluent, . .	.1445	.1664	.1468	.2319	.1724	.7338	.9740
Iron, effluent, ...	2.1042	2.2454	1.8100	1.7633	1.9807	.6395	.5203

The improvement in the effluent effected by the construction of additional underdrains and the placing of distributors on the beds to secure a uniform distribution of sewage, is very plainly shown by the figures in the above table. The increase in the nitrogen in the form of nitrates and the reduction in the amount of iron which has been accomplished during the past two years, and especially during the past year, as compared with the results during the years 1906 to 1909, furnish conclusive evidence of the material improvement which has been effected. The cost of maintaining the filter-beds has been as follows: —

Labor, ...	$3,702 75
Supplies and expenses, ...	94 77
Total, ...	$3,797 52
Cost per million gallons treated, ...	12 63

The cost per million gallons treated was $1.39 greater than for the previous year, due largely to an increase in the rates paid to laborers.

ENGINEERING.

In addition to the routine work in connection with the supervision of the maintenance and operation of the works, the engineering force has completed a survey of Framingham Reservoir No. 2, showing property of the Commonwealth, and has partially completed a similar survey of Framingham Reservoir No. 1. Levels have been taken by means of which the capacity of Lake Cochituate is to be accurately determined for the upper ten feet of its depth. An estimate has been prepared of the cost of works designed for filtering the water drawn from Lake Cochituate.

Appended to this report are tables giving the amount of work done and other information relative to contracts, a series of tables relating to the maintenance of the Metropolitan Water Works, including the rainfall, yield of sources of supply, consumption of water in the different districts, the number of service pipes, meters and fire hydrants in the Metropolitan Water District, and a summary of statistics for the year 1911.

Respectfully submitted,

DEXTER BRACKETT,
Chief Engineer.

BOSTON, Jan. 1, 1912.

REPORT OF CHIEF ENGINEER OF SEWERAGE WORKS.

To the Metropolitan Water and Sewerage Board.

Gentlemen: — The following is a report of the operations of the Engineering Department of the Metropolitan Sewerage Works for the year ending December 31, 1911.

Organization.

The engineering organization during the year has been as follows: —

Division Engineers:

Frederick D. Smith, .	*In charge of maintenance and construction, South Metropolitan System.*
Frank I. Capen, . .	*In charge of maintenance and construction, North Metropolitan System.*
Henry T. Stiff, . .	*In charge of office and drafting room.*

In addition to the above, the average number of engineering and other assistants employed during the year was 10, which includes 1 assistant engineer, 3 instrumentmen, 2 inspectors, 2 draftsmen and 2 stenographers.

METROPOLITAN SEWERAGE DISTRICTS.

Areas and Populations.

During the year no changes have been made in the extent of the sewerage districts as given in the last annual report.

The populations of the district, as given in the following table, are based on the census of 1910.

Table showing Areas and Estimated Populations within the Metropolitan Sewerage District, as of December 31, 1911.

	City or Town.	Area (Square Miles).		Estimated Population.	
North Metropolitan District.	Arlington,	5.20		11,910	
	Belmont,	4.66		5,960	
	Boston (portions of),	3.45		104,450	
	Cambridge,	6.11		107,320	
	Chelsea,	2.24		34,180	
	Everett,	3.34		35,510	
	Lexington,[1]	5.11		4,160	
	Malden,	5.07		46,310	
	Medford,	8.35		24,490	
	Melrose,	3.73		16,210	
	Revere,	5.86		19,610	
	Somerville,	3.96		80,220	
	Stoneham,	5.50		7,480	
	Wakefield,	7.65		11,810	
	Winchester,	5.95		9,700	
	Winthrop,	1.61		10,860	
	Woburn,	12.71		15,690	
			90.50		545,870
South Metropolitan District.	Boston (portions of),	20.39		189,690	
	Brookline,	6.81		29,210	
	Dedham,[1]	9.40		9,480	
	Hyde Park,	4.57		16,090	
	Milton,	12.59		8,220	
	Newton,	16.88		41,330	
	Quincy,	12.56		34,200	
	Waltham,	13.63		28,840	
	Watertown,	4.04		13,520	
			100.87		370,580
	Totals,		191.87		916,450

[1] Part of town.

METROPOLITAN SEWERS.

SEWERS PURCHASED AND CONSTRUCTED AND THEIR CONNECTIONS.

During the year additions by purchase or otherwise have been made within the sewerage districts, so that there are now 103.336 miles of Metropolitan sewers. Of this total, 9.642 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts, the remaining 93.694 miles of Metropolitan sewers and other works having been constructed by the Metropolitan boards.

The locations, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the system: —

North Metropolitan System.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1911.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Boston: —					
Deer Island,	6′ 3″ to 9′,	1.367	4	–	–
East Boston,	9′ to 1′,	5.467	24	Shoe factory,	1
Charlestown,	6′ 7″ ×7′ 5″ to 1′,	3.292	14	Navy Yard,	8
				Almshouse,	1
Winthrop,	9′,	2.864	12	Club House,	1
				Fire Dept. Station,	1
				Private Building,	1
Chelsea,	8′ 4″×9′ 2″ to 1′ 10″×2′ 4″,	5.123	10	Bakery,	1
				Rendering works,	1
				Metropolitan Water Works blow-off,	1
				Chelsea Water Works blow-off,	2
Everett,	8′ 2″×8′ 10″ to 4′ 8″×5′ 1″,	2.925	6	Metropolitan Water Works blow-off,	1
				Cameron Appliance Co.,	1
				Shultz-Goodwin Co.,	1
				Andrews-Wasgatt Co.,	1
				National Metallic Bed Co.,	1
				Linoide Co.,	1
Malden,	4′ 6″×4′ 10″ to 1′,	5.844[1]	30	Metropolitan Water Works blow-off,	1
				Private buildings,	158
Melrose,	4′ 6″×4′ 10″ to 10″,	6.099[2]	36	Private buildings,	111
				Factory,	1
				Railroad station,	1
Cambridge,	5′ 2″×5′ 9″ to 1′ 3″,	7.167	37	Slaughter house,	1
				City Hospital,	2
				Street Railway Machine Shop,	1
Somerville,	6′ 5″×7′ 2″ to 1′ 10″×2′ 3″,	3.471	10	Tannery,	1
				Slaughter-houses (3),	1
				Car-house,	1
				Street railway power house,	1
				Stable,	1
				Rendering works,	1
Medford,	4′ 8″×5′ 1″ to 10″,	5.359	22	Armory building,	1
				Private buildings,	8
				Stable,	1
				Police sub-station,	1
Winchester,	2′ 11″×3′ 3″ to 1′ 3″,	6.428	13	Tannery,	4
				Private buildings,	2
				Gelatine factory,	1
				Stable,	1
				Railroad station,	1
Stoneham,	1′ 3″ to 10″,	0.010	4	–	–
Woburn,	1′ 10″×2′ 4″ to 1′ 3″,	0.933	3	Glue factory,	1
Arlington,	1′ 6″ to 10″,	3.520[3]	35	Private buildings,	132
				Railroad station,	1
				Car-house,	3
				Post Office,	1
Belmont,[4]	–	–	3	–	–
Wakefield,[4]	–	–	1	–	–
Revere,	4′ to 3′,	0.048	2	–	–
		59.917[5]	266		464

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[1] Includes 1.84 of a mile of sewer purchased from the city of Malden.

[2] Includes .736 of a mile of sewer purchased from the city of Melrose.

[3] Includes 2.631 miles of sewer purchased from the town of Arlington.

[4] The Metropolitan sewer extends but a few feet into the towns of Belmont and Wakefield.

[5] Includes 2.787 miles of Mystic River valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.

South Metropolitan System.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1911.	Special Connections.	
				Character or Location of Connection.	Number in Operation.
Boston (Back Bay),	6′ 6″ to 3′ 9″,	1.500[1]	13	Tufts Medical School, Private house, Administration Building, Boston Park Department, Simmons College buildings, Art Museum,	1 1 1 1 2
Boston (Brighton),	5′ 9″ ×6′ 0″ to 12″,	6.010[2]	14	Abattoir,	3
Boston (Dorchester).	3′×4′ to 2′ 6″×2′ 7″,	2.870[3]	12	Chocolate works, Machine shop, Paper mill, Private buildings,	2 1 1 2
Boston (Roxbury),	6′ 6″×7″, 4′ 0″,	1.430	–	– –	–
Boston (West Roxbury).	9′ 3″×10′ 2″ to 12″,	7.600	12	Parental school, Lutheran Evangelical Church, Private buildings,	1 1 4
Brookline,	6′ 6″×7′ 0″ to 8″,	2.540[4]	12	– –	–
Dedham,	4′×4′ 1″ to 3′ 9″×3′ 10″,	2.350	6	– –	–
Hull,	60″ pipe,	0.750	–	– –	–
Hyde Park,	10′ 7″×11′ 7″ to 4′×4′ 1″,	4.527	17	Mattapan Paper Mills, Private buildings,	1 2
Milton,	11′×12′ to 8″,	3.600	18	Private buildings,	2
Newton,	4′ 2″×4′ 9″ to 1′ 3″,	2.911	6	Private houses,	2
Quincy,	11′ 3″×12′ 6″ to 24″ pipe,	6.580	12	– –	–
Waltham,	3′ 6″×4′,	0.001	1	– –	–
Watertown,	4′ 2″×4′ 9″ to 12″,	0.750[5]	5	Factories, Stanley Motor Carriage Co., Knights of Pythias Building,	2 1 1
		43.419	128		32

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[1] Includes .355 of a mile of sewer purchased from the city of Boston.

[2] Includes .446 of a mile of pipe and concrete sewers built for the use of the city of Boston; also, .026 of a mile of sewer purchased from the town of Watertown.

[3] Includes 1.24 miles of sewer purchased from the city of Boston.

[4] Includes .158 of a mile of pipe sewer built for the use of the town of Brookline.

[5] Includes .025 of a mile of sewer purchased from the town of Watertown.

COST OF CONSTRUCTION.

[To December 31, 1911.]

The cost of the 103.336 miles of Metropolitan sewers enumerated above, including six pumping stations, screen-house, electric lifting station, siphons and appertaining structures, may be summarized as follows: —

North Metropolitan System,	$6,686,891 50
South Metropolitan System,	8,813,232 53
	$15,500,124 03

Information relating to areas, populations, local sewer connections and other data for the whole Metropolitan Sewerage District appear in the following table: —

North Metropolitan District.

Area (Square Miles).	Estimated Total Population.	Miles of Local Sewer connected.	Estimated Population contributing Sewage.	Ratio of Contributing Population to Total Population (Per Cent.).	CONNECTIONS MADE WITH METROPOLITAN SEWERS.	
					Public.	Special.
90.50	545,870	683.05	480,600	88.0	266	464

South Metropolitan District.

100.87	370,580	557.52	241,865	65.3	128	32

Entire Metropolitan District.

191.37	916,450	1,240.57	722,465	78.8	394	496

Of the estimated gross population of 916,450 on December 31, 1911, 722,465, representing 78.8 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1,240.57 miles of local sewers owned by the individual municipalities. These sewers are connected with the Metropolitan System by 394 public and 496 special connections. It appears, also, that there has been during the year an increase of 29.25 miles of local sewers connected with the Metropolitan System, and that 14 public and 25 special connections have been added.

PUMPING STATIONS AND PUMPAGE.

The following table shows the average daily volume of sewage lifted at each of the six Metropolitan pumping stations during the year, as compared with the corresponding volumes for the previous year.

Tables for estimating flows in main sewers below the East Boston and Charlestown pumping stations were prepared about the year 1900, when the sewers were comparatively new and the surfaces smooth, and have been used in engine house computations since that date. These sewers have now become more or less covered with slime and the flow somewhat retarded.

Recently a Venturi meter has been installed at Deer Island for measuring the sewage flow. In connection with tests of the new engines at the Deer Island and East Boston pumping stations, observations have been made on present sewage flows in these sewers by the Venturi meter and otherwise. As a result of these later observations, deductions from the earlier ratings of the sewers have been made, 7 per cent. for the East Boston station and 6 per cent. for the Charlestown station.

The tables of pumping in this report have been prepared from the last ratings of sewage flows in the main sewers, as above outlined.

PUMPING STATION.	AVERAGE DAILY PUMPAGE.			
	Jan. 1, 1910, to Dec. 31, 1910.	Jan. 1, 1911, to Dec. 31, 1911.	Decrease during the Year.	
	Gallons.	Gallons.	Gallons.	Per Cent.
Deer Island,	59,000,000	52,800,000	6,200,000	10.5
East Boston,	57,000,000	50,800,000	6,200,000	10.9
Charlestown,	34,300,000	32,600,000	1,700,000	5.0
Alewife Brook,	3,585,000	3,012,000	573,000	16.0
Quincy,	4,132,000	4,069,000	63,000	1.5
Ward Street (actual gallons pumped),	22,900,000	22,600,000	300,000	1.3

CONSTRUCTION.

NORTH METROPOLITAN SYSTEM.

EAST BOSTON STATION.

The construction provided for in Chapters 556 and 582 of the Legislative Acts of 1908 for repairs and extensions to the East Boston pumping station, including new engine, boiler and coal houses and wharf, with an additional engine, boilers, piping and connections, has been practically completed during the year.

The contracts for the building and wharf were completed at the time of the last report and were described in that report. The reinforced concrete floor of the wharf has been placed during the year by day labor under the direction of the engineer. Concrete reinforcement around some of the piles has also been constructed by day labor. The remaining piles will be reinforced from time to time by the maintenance labor during coming years. The wharf deck was completed in condition for use in the middle of September.

The work of erecting the 100,000,000-gallon centrifugal pump and engine was commenced about January 1, 1911, and the pump was in condition to operate in April. It was put into the regular service of the station September 25, 1911. The official test on this engine was made December 1, 1911.

The six vertical boilers erected under contract with the Robb-Mumford Boiler Company were first put into service July 15.

The valves for piping were furnished by the Walworth Manufacturing Company and the Crane Company.

On March 15, a contract was made with the Lumsden & Van Stone Company for furnishing and erecting all main piping in the new boiler room and new and old engine rooms and basement of new engine room. This work was completed on August 19.

The piping and boilers were covered by the Philip Carey Company. This work was completed September 30. A tile floor in the new engine room has been placed during the year by maintenance labor, together with granolithic sidewalk in front of the station. The six old boilers and old economizer have been removed. The old boiler room has been rearranged by new partitions for office, toilet and work rooms. There remain to be completed some renewals and rearrangement of screens and screen-house, and this matter is still under consideration by the Board.

STABLE AND LOCKER BUILDING.

The reinforced concrete locker building, described in the last report, was completed about June 1. The fitting of the building, including plumbing, wiring, piping for heating, stalls, etc., was done by the maintenance labor. The building was completed ready for occupancy about September 1. The cost of the building was $14,166.75, and the sum of $4,524.40 was paid on account of the land, making a total of $18,691.15 expended for this purpose.

TEST OF EAST BOSTON ENGINE.

The tests of the 100,000,000-gallon engine and centrifugal pump at East Boston, specified in the contract with the Allis-Chalmers Company, were carried out December 1, 1911. The tests were made under the direction of Frank I. Capen, Division Engineer, and William M. Francis, Mechanical Engineer, for the Metropolitan Sewerage Works, and J. R. Belknap, Mechanical Engineer for the Allis-Chalmers Company.

The engine, pump and connecting piping were furnished by the

Allis-Chalmers Company, of Milwaukee, Wis., under a contract dated June 5, 1909.

The pump and engine were erected between December, 1910, and April, 1911, and were first operated in June, 1911. By agreement between the Board and the Allis-Chalmers Company, they have been operated in the regular service of the station since September 25, 1911, and prior to official test and acceptance by the Board.

The following table contains principal dimensions of engine and pump: —

Principal Dimensions of Engine and Pump.

Diameter H. P. cylinder (inches),	18
Diameter I. P. cylinder (inches),	32
Diameter L. P. cylinder (inches),	46
Stroke of pistons (inches),	30
Diameter of suction (inches),	60
Diameter of discharge (inches),	60
Revolutions per minute,	89.3 to 106.1

Contract Requirements.

The contract for the engine contained requirements as follows: —

The capacity must equal 100,000,000 United States gallons of sewage per twenty-four hours when lifting vertically 19 feet, the quantity of sewage to be determined by measurements in the discharge sewer at points below the station selected by the Engineer. The actual head against which the pump is acting is to be measured every fifteen minutes by a mercury or other approved gauge, at a point near the pump end of the discharge channel. The elevations in the suction channel are to be taken every fifteen minutes by a gauge in the manhole near the easterly end of the station. The duty of the engine and pump guaranteed by the contractor is 96,500,000 foot pounds for each 1,000 pounds of commercially dry steam delivered by the Board at the throttle valve of the engine. In this test steam containing less than one and one-half per cent. of entrained water, as determined by calorimeter measurements, is to be considered as commercially dry steam. The duration of the test is to be twelve hours. The sewage is to be screened and to consist of about two-thirds ordinary domestic sewage and about one-third of sea water introduced into the sewer at convenient points. The engine and pump are to be operated continuously during the twelve hours of the trial under the conditions before outlined and steam supplied shall not have more than 125 pounds pressure per square inch at the throttle valve. The official trial of the engine and pump is to be conducted jointly by the Engineer and a representative of the contractor, and if the duty determined by this trial shall be less than that guaranteed by the contractor, the sum of five hundred dollars ($500) for each one million foot pounds below the guaranteed duty and pro rata for fractional parts, shall be deducted from the price bid by the contractor. If the duty shown by the official trial shall be ten per cent. less than that guaranteed in the contract, the Board may reject the engine and pump.

Trial.

The capacity of the engine to lift 19 feet when pumping at a rate of 100,000,000 gallons per 24 hours was established during the official duty test of December 1, and during wet and stormy weather of the period of probation when the engine was run in the regular service of the house prior to formal test and acceptance, as noted above.

To obtain sufficient water for the duty test of December 1, tide water was introduced into the sewer through tide gates at Malden River and at Chelsea Creek. The fluctuating head of the tide gave a varying supply of water to the pump, at times above 100,000,000 gallons per day and at times below 100,000,000 gallons per day. The normal lift of sewage at the station approximates 16 feet. The losses of head through the connecting channels credited to the pump by terms of the contract, were found by trial to approximate 2 feet for a discharge of 100,000,000 gallons per 24 hours. The lift contemplated in the contract during duty test was therefore 18 feet. Steam was furnished for the test by two boilers excluded from other service of the station and conveyed to the engine through one of the 8-inch steam lines excluded from other service. The feed water was weighed in barrels and pumped through an economizer to the boilers by an auxiliary pump on the engine. Quarter-hour records of pressure gauges and other apparatus used in connection with the test were made. The head pumped against was determined by a water column near the pump end of the discharge channel. Elevations of sewage in the suction chamber were measured by means of a hook gauge at a manhole near the pumping station. The quantity of sewage pumped was determined by meter measurements of the sewage flow in the main sewer about 1,000 feet below the East Boston pumping station. Calorimeter measurements to determine the moisture of steam were made at intervals of fifteen minutes.

The observers were employés of the Metropolitan Water and Sewerage Board.

Trial Data and Results.

Date of trial,	December 1, 1911.
Duration of trial,	12 hours.

Average Pressure.

Steam at throttle (pounds),	126.03
First receiver (pounds),	23.60
Second receiver (pounds),	7.02
Vacuum (inches of mercury),	26.68

Head pumped against.

Average elevation of sewage in discharge sewer,	109.02
Average elevation of sewage in discharge channel, including losses in discharge tube and appurtenances,	111.08
Average elevation of sewage in suction,	91.71
Average lift credited to pump in contract,	19.37
Minimum lift pumped against,	18.33
Maximum lift pumped against,	20.27

Revolutions.

Total revolutions during test,	72,585.00
Average revolutions per minute,	100.81

Useful Work performed by Engine.

Total water pumped (United States gallons per twenty-four hours),	93,900,000

Water fed to Boilers.

Total water weighed (pounds),	72,232.50
Deduct leakage from boilers, pipes, valves and wastes from calorimeter,	2,533.38
Total steam chargeable to engine,	69,699.00
Average entrainment of moisture in steam entering engine in excess of 1½ per cent. (average entrainment 1⅛ per cent.),	0.00
Total dry steam used by engine (pounds),	69,699.00

Duty.

Duty in foot pounds per 1,000 pounds commercially dry steam corrected for losses,	109,000,000
Duty in foot pounds per 1,000 pounds water fed to boilers,	105,200,000

Horse Power and Efficiency.

Average indicated horse power,	472.20
Average water horse power,	319.81
Efficiency per cent.,	67.73
Water per indicated horse power per hour (pounds),	12.30

The work of the engine during the test slightly exceeded the work specified in the contract. The duty developed by the engine during its test of 109,000,000 foot pounds of work for each 1,000 pounds of commercially dry steam used exceeds the duty of 96,500,000 foot pounds guaranteed by the engine builders in their contract by 13 per cent.

SECTIONS 65 AND 66. — MALDEN AND EVERETT EXTENSION.

Chapter 547 of the Acts of 1910 authorized the Board to purchase of the City of Malden an existing city sewer in Eastern Avenue extending from the Metropolitan sewer in Bryant Street to Broadway, and to construct a new sewer in Broadway from Eastern Avenue to the Everett city line. The Board and the City of Malden did not come to an agreement during the year 1910 about the purchase of the city sewer. The Legislature of 1911 repealed chapter 547 of 1910 and by chapter 512 of the Acts of 1911 again authorized the Board to purchase the existing city sewer and construct a new sewer in Broadway, as above outlined.

The city sewer in Eastern Avenue was purchased on June 16, 1911, having the following lengths and sizes of sewer: —

30-inch brick sewer,	3,066 linear feet.
24-inch brick sewer,	1,433 linear feet.
Total length,	4,499 linear feet.

This length of city sewer purchased is known as Section 65 and the new 18-inch and 12-inch pipe sewer constructed by the Board in Broadway to the Everett city line as Section 66 of the North

Metropolitan Sewerage System. The new sewer provides specially for the sanitary drainage of about 80 acres in the northeasterly portion of Malden in the vicinity of Broadway, and about 80 acres in the northwesterly section of Everett.

The construction of the new sewer in Broadway was carried out by Antonio G. Tomasello and is described in detail below: —

Contract 81, Section 66. — Malden and Everett Extension.

Division Engineer in Charge. — FRANK I. CAPEN.
Contractor. — ANTONIO G. TOMASELLO, Boston, Mass.

This contract involved the construction of 2,520 lin. ft. of 18-inch pipe sewer and 112 lin. ft. of 12-inch pipe sewer extending from the city sewer purchased of Malden and beginning at the junction of Eastern Avenue and Broadway, extending southerly through Broadway to the Everett city line at a point about 100 feet southerly from Grover Street, a total distance of 2,632 lin. ft.

For 200 feet near Eastern Avenue the excavation was in wet sand and gravel to clay near the sewer location. For 650 feet to near Sheafe Street the excavation was largely through rock, with sand and gravel above the rock. For 1,350 feet, the excavation was through very fine and very wet sand. For about 300 feet near the end of the section, the excavation was in dry sand, gravel and clay. For a length of about 600 feet near Sheafe Street, largely through the rock section, the excavation was carried out by bucket excavating machinery. For the remainder of the section, excavation was carried out without the aid of machinery.

The construction was commenced June 19, 1911, and completed December 6, 1911. About 438 cu. yds. of rock were excavated. The sewer was built of Akron pipe reinforced with about 6 inches of concrete. The average depth of the excavation was 15 feet, varying from a minimum of 10 feet to a maximum of 23 feet. When the sewer was at a greater depth than 9 feet below the surface, 6-inch pipe chimneys, reinforced with concrete, were built.

MAINTENANCE.

SCOPE OF WORK AND FORCE EMPLOYED.

The maintenance of the Metropolitan Sewerage System includes the operation of 7 stations and 103.336 miles of Metropolitan sewers, receiving the discharge from 1,240.57 miles of town and city sewers at 396 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force of 165 men includes 108 engineers and other employés at the pumping stations, and 57 men employed on actual sewer maintenance and care of pumping station grounds. In the following two tables the use of the completed systems and other data are shown: —

NORTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage in this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1911.]

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.[1]	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Boston (Deer Island), .	0.70	Separate, . . .	–	–	1,207[2]	1,207[2]	–	–	100.0	–
Winthrop, . . .	30.22	Separate, . . .	2,507	4.25	10,655	10,860	1.30	1.61	98.1	80.7
Boston (East Boston), .	30.68	Separate and combined,	4,673	12.50	58,413	61,250	1.08	2.18	95.4	49.5
Chelsea, ...	29.39[3]	Separate and combined,	3,589[4]	9.00	32,300	34,180	1.10	2.24	94.5	49.1
Everett, ...	44.75	Separate and combined,	4,434	6.60	29,265	35,510	1.92	3.34	82.4	57.5
Malden, ...	57.89	Separate, . . .	5,834	6.20	36,170	46,310	2.91	5.07	78.0	57.4
Melrose, ...	36.38	Separate, . . .	2,861	4.60	13,160	16,210	1.77	3.73	81.2	47.5
Boston (Charlestown), .	21.16	Separate and combined,	5,298	7.85	41,590	41,993	0.67	1.27	99.0	52.8
Cambridge, . . .	145.44	Separate and combined,	15,562	6.80	105,820	107,320	5.01	6.11	98.6	82.0
Somerville, . . .	95.38	Separate and combined,	14,502	5.45	79,035	80,220	3.35	3.96	98.5	84.6
Medford, . . .	54.35	Separate, . . .	4,175	5.75	24,005	24,490	2.91	8.35	98.0	34.9
Winchester, . . .	24.77	Separate, . . .	1,328	5.40	7,170	9,700	1.25	5.95	73.9	21.0
Woburn, . . .	14.35[5]	Separate, . . .	1,083	5.70	6,175	15,690	0.96	12.71	39.4	7.6
Stoneham, . . .	12.60	Separate, . . .	783	4.90	3,835	7,480	0.66	5.50	51.3	12.0
Arlington, . . .	24.24	Separate, . . .	1,360	6.10	8,295	11,910	1.74	5.20	69.7	33.5
Belmont, . . .	14.32	Separate, . . .	647	6.40	4,665[6]	5,960	1.09	4.66	78.3	23.4
Wakefield, ...	12.23	Separate, . . .	595	5.60	3,330	11,810	0.48	7.65	28.2	6.3
Lexington,[7] . . .	–	– –	–	–	–	4,160	–	5.11	–	–
Revere, ...	34.20	Separate, . . .	2,629	5.90	15,510	19,610	1.81	5.86	79.1	30.9
Totals, . . .	683.05	– –	71,860	6.70	480,600	545,870	30.01	90.50	88.0	33.2

[1] Estimated from assessors' statement of the number of houses in each city or town, on April 1, 1911, and the population from census of 1910.

[2] Estimated by Superintendent James H. Cronin of the Institution on Deer Island.

[3] The districts connecting at Cypress Street, Revere Beach Parkway, Springvale Avenue, Willoughby, Bellingham, Highland, Hawthorn and Spruce streets are now contributing sewage.

[4] Estimated.

[5] Exclusive of Mystic River valley sewer and tanneries.

[6] Including 2 connections with McLean Hospital, having an estimated population of 525.

[7] Lexington not connected.

SOUTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1911.]

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.[1]	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Boston (Back Bay), .	24.78	Separate and combined,	1,629	17.00	27,695	28,230	1.24	1.61	98.1	77.0
Boston (Brighton), .	57.49	Separate and combined,	3,090	6.30	19,465	28,460	3.17	3.74	68.4	84.8
Brookline, . . .	66.32	Separate and combined,	3,803	7.35	27,950	29,210	3.46	6.81	95.7	50.8
Newton, . . .	112.43	Separate, . . .	6,046	6.00	36,275	41,330	7.22	16.88	87.8	42.8
Watertown, . . .	36.24	Separate, . . .	1,920	5.40	10,370	13,520	1.97	4.04	76.7	48.8
Waltham, . . .	43.41	Separate, . . .	3,505	7.65	26,815	28,840	2.23	13.63	93.0	16.4
Boston (Dorchester), .	50.93	Separate and combined,	4,874	7.70	37,530	62,500	2.37	4.89	60.0	48.5
Milton, ...	10.40	Separate and combined,	522	5.20	2,715	8,220	0.66	12.59	33.0	5.2
Hyde Park, . . .	26.90	Separate, . . .	1,804	7.20[2]	13,000	16,090	1.31	4.57	80.8	28.7
Dedham, . . .	15.63	Separate, . . .	591	5.20	3,075	9,480[3]	0.78	9.40	32.4	8.3
Boston (Roxbury), .	-	- -	-	-	-	41,100	-	1.23	-	-
Boston (West Roxbury),	49.39	Separate and combined,	2,963	5.80	18,270[4]	29,400	2.32	8.92	62.1	26.0
Quincy, ...	63.60	Separate, . . .	3,668	5.10	18,705	34,200	2.92	12.56	54.7	23.2
Totals, . . .	557.52	- -	34,415	7.00	241,865	370,580	29.65	100.87	65.3	29.4

[1] Estimated from assessors' statement of the number of houses in each city or town, on April 1, 1911, and the population from census of 1910.

[2] Estimated by Town Engineer.

[3] Part of town not included in Metropolitan Sewerage District.

[4] Including connection with Institution at Austin Farm, having an estimated population of 1,083.

CAPACITY AND RESULTS.

The following tables summarize the pumping records for the year for the Metropolitan sewerage stations: —

NORTH METROPOLITAN SYSTEM.

Deer Island Pumping Station.

At this station are four submerged centrifugal pumps with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons, with 19-foot lift.
Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 52,600,000 foot-pounds.
Average quantity raised each day: 52,800,000 gallons.
Force employed: 4 engineers, 1 relief engineer, 4 firemen, 3 oilers, 3 screenmen, 1 relief screenman and 1 laborer.
Coal used: Georges Creek, Pocahontas and New River, costing from $3.92 to $4.109 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1911.						
January,	**1,536,500,000**	**49,600,000**	**37,500,000**	**81,200,000**	**10.80**	**46,000,000**
February,	**1,457,000,000**	**52,100,000**	**40,500,000**	**85,100,000**	**10.88**	**43,200,000**
March,	**1,708,800,000**	**55,200,000**	**41,800,000**	**80,400,000**	**10.28**	**50,300,000**
April,	**1,760,500,000**	**58,700,000**	**46,700,000**	**97,400,000**	**11.14**	**55,100,000**
May,	**1,409,000,000**	**45,500,000**	**38,800,000**	**51,500,000**	**10.53**	**50,200,000**
June,	**1,665,300,000**	**55,600,000**	**48,700,000**	**87,200,000**	**11.26**	**58,700,000**
July,	**1,648,100,000**	**53,200,000**	**40,500,000**	**83,000,000**	**10.67**	**59,500,000**
August,	**1,614,200,000**	**52,100,000**	**42,200,000**	**93,700,000**	**11.43**	**62,900,000**
September,	**1,472,100,000**	**49,100,000**	**38,900,000**	**68,400,000**	**11.07**	**48,300,000**
October,	**1,531,200,000**	**49,400,000**	**39,200,000**	**71,000,000**	**10.62**	**46,500,000**
November,	**1,633,000,000**	**54,400,000**	**36,800,000**	**83,300,000**	**11.19**	**52,300,000**
December,	**1,821,400,000**	**58,800,000**	**42,500,000**	**103,000,000**	**11.50**	**58,200,000**
Total,	**19,257,100,000**	-	-	-	-	-
Average,	-	**52,800,000**	**41,200,000**	**82,100,000**	**10.95**	**52,600,000**

East Boston Pumping Station.

At this station are four submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons with 19-foot lift.
Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 62,100,000 foot-pounds.
Average quantity raised each day: 50,800,000 gallons.
Force employed: 4 engineers, 2 relief engineers, 4 firemen, 1 relief fireman, 3 oilers, 3 screenmen, 1 relief screenman, 3 helpers, and 1 laborer.
Coal used: New River, costing from $3.735 to $4.10 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1911.						
January,	1,478,900,000	47,600,000	35,600,000	79,800,000	15.33	54,900,000
February,	1,405,000,000	50,100,000	38,700,000	83,200,000	15.32	56,500,000
March,	1,651,100,000	53,200,000	39,900,000	78,600,000	15.53	58,400,000
April,	1,704,700,000	56,700,000	44,800,000	95,500,000	15.71	64,300,000
May,	1,351,400,000	43,500,000	37,000,000	49,700,000	15.47	66,800,000
June,	1,609,500,000	53,600,000	46,900,000	85,400,000	15.38	66,900,000
July,	1,590,400,000	51,200,000	38,700,000	81,200,000	15.46	53,400,000
August,	1,556,500,000	50,100,000	40,400,000	91,900,000	15.40	56,500,000
September,	1,416,300,000	47,100,000	37,000,000	66,500,000	15.60	67,200,000
October,	1,473,500,000	47,400,000	37,300,000	69,100,000	15.54	69,100,000
November,	1,577,200,000	52,400,000	35,000,000	81,500,000	15.69	63,800,000
December,	1,763,700,000	56,900,000	40,600,000	101,100,000	15.90	67,800,000
Total,	18,578,200,000	-	-	-	-	-
Average,	-	50,800,000	39,300,000	80,300,000	15.53	62,100,000

Charlestown Pumping Station.

At this station are three submerged centrifugal pumps, two of them having impellers or wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: two, 22,000,000 gallons each, with 11-foot lift; one, 60,000,000 gallons, with 8-foot lift.

Average duty for the year: 55,600,000 foot-pounds.

Average quantity raised each day: 32,600,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.

Coal used: New River, costing from $3.685 to $3.90 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1911.						
January, ...	960,900,000	31,000,000	22,700,000	45,500,000	8.29	49,800,000
February, . . .	948,800,000	33,900,000	25,300,000	52,400,000	8.36	53,200,000
March, ...	1,030,300,000	33,200,000	26,100,000	47,800,000	8.39	52,300,000
April, ...	1,008,000,000	33,600,000	25,700,000	56,700,000	8.40	56,500,000
May, ...	914,700,000	29,500,000	24,200,000	32,100,000	8.15	55,700,000
June, ...	996,900,000	33,200,000	26,200,000	49,000,000	8.28	58,200,000
July, ...	1,018,700,000	32,900,000	24,500,000	63,100,000	8.21	54,600,000
August, ...	1,070,300,000	34,500,000	26,400,000	55,600,000	8.34	60,400,000
September, . . .	984,900,000	32,800,000	25,300,000	39,900,000	8.36	59,100,000
October, ...	918,300,000	29,600,000	23,300,000	42,800,000	8.06	52,500,000
November, . . .	1,043,400,000	34,800,000	24,300,000	52,300,000	8.32	60,200,000
December, . . .	1,014,100,000	32,700,000	21,800,000	65,400,000	8.38	54,500,000
Total, . . .	11,909,300,000	-	-	-	-	-
Average, . . .	-	32,600,000	24,700,000	50,200,000	8.30	55,600,000

Alewife Brook Pumping Station.

The plant at this station consists of the original installation of small commercial pumps and engines, *i.e.*, two 9-inch Andrews vertical centrifugal pumps, with direct-connected compound marine engines, together with the recent additions. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the two original pumps: 4,500,000 gallons each, with 13-foot lift.

Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.

Average duty for the year: 16,900,000 foot-pounds.

Average quantity raised each day: 3,012,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen, and 1 relief screenman.

Coal used: New River and Pocahontas, costing from $4.365 to $4.55 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1911.						
January,	94,417,000	3,046,000	2,414,000	5,170,000	12.97	16,900,000
February,	97,352,000	3,477,000	2,598,000	5,494,000	12.42	16,400,000
March,	107,291,000	3,461,000	2,550,000	5,668,000	12.27	16,600,000
April,	123,105,000	4,103,000	3,380,000	6,076,000	12.54	19,900,000
May,	84,643,000	2,730,000	2,246,000	3,574,000	13.05	18,000,000
June,	75,152,000	2,505,000	2,203,000	4,615,000	12.97	16,800,000
July,	68,067,000	2,196,000	1,783,000	4,738,000	12.89	15,400,000
August,	71,647,000	2,311,000	1,700,000	4,983,000	12.88	15,700,000
September,	73,277,000	2,443,000	2,036,000	3,079,000	12.94	16,200,000
October,	84,008,000	2,710,000	2,330,000	3,814,000	12.93	16,000,000
November,	91,530,000	3,051,000	2,203,000	4,922,000	12.83	16,300,000
December,	127,373,000	4,109,000	3,380,000	7,580,000	12.55	18,400,000
Total,	1,097,862,000	-	-	-	-	-
Average,	-	3,012,000	2,402,000	4,976,000	12.77	16,900,000

SOUTH METROPOLITAN SYSTEM.

Ward Street Pumping Station.

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of pumps: two, 50,000,000 gallons each, with 45-foot lift.
Average duty for the year: 79,400,000 foot-pounds.
Average quantity raised each day: 22,600,000 gallons.
Force employed: 4 engineers, 1 relief engineer, 4 firemen, 4 oilers, 4 assistant engineers, 1 machinist and 1 laborer.
Coal used: New River, costing from $3.527 to $4.26 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	†Average Duty (ft.-lbs. per 100 lbs. Coal).
1911.						
January,	634,200,000	20,500,000	16,600,000	28,000,000	39.74	74,600,000
February,	685,900,000	24,500,000	18,500,000	38,900,000	40.70	86,800,000
March,	697,400,000	22,500,000	17,600,000	32,400,000	40.90	79,600,000
April,	769,000,000	25,600,000	20,500,000	38,100,000	41.38	86,100,000
May,	617,200,000	19,900,000	17,000,000	22,600,000	40.61	78,300,000
June,	651,900,000	21,700,000	16,000,000	35,900,000	39.80	82,200,000
July,	607,300,000	19,600,000	15,400,000	42,200,000	39.48	77,700,000
August,	595,300,000	19,200,000	15,900,000	33,300,000	39.89	75,900,000
September,	631,600,000	21,100,000	17,100,000	27,300,000	40.01	76,300,000
October,	734,200,000	23,700,000	19,900,000	28,900,000	40.09	71,200,000
November,	748,200,000	24,900,000	19,200,000	34,800,000	40.52	79,700,000
December,	856,100,000	27,600,000	21,400,000	47,400,000	40.58	84,000,000
Total,	8,228,300,000	-	-	-	-	-
Average,	-	22,600,000	17,900,000	34,100,000	40.31	79,400,000

Records from plunger displacement.
Average slip for the year about 14.7 per cent.

Quincy Pumping Station.

At this station are two compound condensing Deane pumping engines and one Lawrence centrifugal pump driven by a Sturtevant compound condensing engine.

Contract capacity of pumps: 3,000,000 Deane; 5,000,000 Deane; 10,000,000 Lawrence centrifugal.

Average duty for the year: 32,942,000 foot-pounds.

Average quantity raised each day: 4,069,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: Cumberland, costing from $4.40 to $4.54 per gross ton.

Materials intercepted at screen during year, 183 cubic yards.

Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1911.						
January,	128,350,000	4,140,000	3,680,000	5,600,000	21.19	30,000,000
February,	118,755,000	4,241,000	3,635,000	5,500,000	21.19	30,100,000
March,	131,325,000	4,236,000	3,770,000	4,790,000	21.11	30,100,000
April,	147,955,000	4,932,000	4,250,000	5,670,000	21.77	35,700,000
May,	119,645,000	3,860,000	3,330,000	4,610,000	21.21	34,400,000
June,	105,512,000	3,517,000	3,100,000	4,145,000	21.18	32,100,000
July,	101,904,000	3,287,000	2,825,000	4,140,000	21.12	31,600,000
August,	106,120,000	3,423,000	3,000,000	4,560,000	21.09	33,000,000
September,	120,190,000	4,006,000	3,550,000	5,430,000	21.01	33,600,000
October,	116,130,000	3,746,000	3,345,000	4,200,000	20.95	33,500,000
November,	130,105,000	4,337,000	3,310,000	5,640,000	21.19	35,300,000
December,	158,140,000	5,101,000	4,440,000	6,020,000	21.89	35,900,000
Total,	1,484,131,000	-	-	-	-	-
Average,	-	4,069,000	3,529,000	5,025,000	21.24	32,942,000

Nut Island Screen-house.

The plant at this house includes two sets of screens in duplicate, actuated by small reversing engines of the Fitchburg type. Two vertical Deane boilers, 80 horse-power each, operate the engines, provide heat and light for the house and burn materials intercepted at the screens, and furnish power for the Quincy sewage lifting station.

Average quantity of sewage passing screens daily, 42,000,000 gallons.
Total materials intercepted at screens during the past year, 1,101.96 cubic yards.
Materials intercepted per million gallons of sewage discharged, 1.94 cubic feet.
Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.
Coal used: New River and Cumberland, costing from $4.05 to $5.50 per gross ton.

COST OF PUMPING.

In the following tables the total cost of pumping and the rate per million foot-gallons at each of six pumping stations are shown in detail: Chapter 494, Acts of 1911, "the Eight-hour Law," so called, has involved extra labor at all stations, increasing the average costs of labor in the tables of averages below.

Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.

Volume (19,257.1 Million Gallons) × Lift (10.95 Feet) = 210,865 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	$12,993 40	$0.06162
Coal,	9,436 69	.04475
Oil,	272 51	.00129
Waste,	96 42	.00046
Water,	1,951 73	.00926
Packing,	206 99	.00098
Miscellaneous supplies and renewals,	854 21	.00405
Totals,	$25,811.95	$0.12241
Labor at screens,	-	.01357

Average Cost per Million Foot-gallons for Pumping at the East Boston Station.

Volume (18,578.2 Million Gallons) × Lift (15.53 Feet) = 288,529 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$17,024 60	$0.05900
Coal,	11,058 33	.03833
Oil,	348 79	.00121
Waste,	107 59	.00037
Water,	1,981 20	.00687
Packing,	123 61	.00043
Miscellaneous supplies and renewals,	1,043 24	.00361
Totals,	$31,687 36	$0.10982
Labor at screens,	-	.00990

Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.

Volume (11,909.3 Million Gallons) × Lift (8.30 Feet) = 98,847 Million Foot-gallons.

Items.	Cost.	Cost per Million Foot-gallons.
Labor,	$11,864 57	$0.12003
Coal,	3,440 42	.03481
Oil,	194 75	.00197
Waste,	80 93	.00082
Water,	475 20	.00481
Packing,	63 53	.00064
Miscellaneous supplies and renewals,	677 48	.00685
Totals,	$16,796 88	$0.16993
Labor at screens,	-	.02991

Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.

Volume (1,097.86 Million Gallons) × Lift (12.77 Feet) = 14,019.7 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	$5,998 79	$0.42788
Coal,	1,509 44	.10767
Oil,	145 84	.01040
Waste,	66 73	.00476
Water,	320 20	.02284
Packing,	15 11	.00108
Miscellaneous supplies and renewals,	192 64	.01374
Totals,	$8,248 75	$0.58837
Labor at screens, oiling and miscellaneous services,	-	.13356

Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.

Volume (8,228.3 Million Gallons) × Lift (40.31 Feet) = 331,683 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	$14,874 51	$0.04484
Coal,	7,708 00	.02323
Oil,	217 74	.00066
Waste,	30 58	.00009
Water,	1,441 20	.00435
Packing,	91 64	.00028
Miscellaneous supplies and renewals,	1,796 60	.00542
Totals,	$26,160 27	$0.07887
Labor at screens,	-	.01317

Average Cost per Million Foot-gallons for Pumping at the Quincy Station.

Volume (1,484.1 Million Gallons) × Lift (21.24 Feet) = 31,522.3 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	$5,428 58	$0.17221
Coal,	1,608 48	.05103
Oil,	39 73	.00126
Waste,	18 82	.00060
Water,	211 17	.00670
Packing,	3 41	.00010
Miscellaneous supplies and renewals,	377 19	.01197
Totals,	$7,687 38	$0.24387
Labor at screens, oiling and miscellaneous services,	-	.04940

Coal for use at the several stations has been purchased as follows: —

	Gross Tons, Bituminous Coal.							
	Deer Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alewife Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screen-house.	Price per Gross Ton.[1]
Staples Coal Company, . .	-	-	-	-	106.990	-	-	$3 527
New England Coal and Coke Company.	-	-	484.08	-	-	-	-	3 69
New England Coal and Coke Company.	-	1,334.385	-	-	-	-	-	3 73
Staples Coal Company, . .	-	-	-	-	138.647	-	-	3 74
New England Coal and Coke Company.	-	-	310.56	-	-	-	-	3 857
New England Coal and Coke Company.	-	-	284.60	-	-	-	-	3 90
Staples Coal Company, . .	-	-	-	-	295.730	-	-	3 90
Staples Coal Company, . .	1,258	-	-	-	-	-	-	3 92
Staples Coal Company, . .	-	-	-	-	138.589	-	-	3 93
Staples Coal Company, . .	-	-	-	-	-	-	370.000	4 054
New England Coal and Coke Company.	-	1,859.495	-	-	-	-	-	4 087
Metropolitan Coal Company, .	1,038	-	-	-	-	-	-	4 109
Metropolitan Coal Company, .	-	-	-	-	-	-	200.000	4 20
Staples Coal Company, . .	-	-	-	-	1,141.578	-	-	4 26
New England Coal and Coke Company.	-	-	-	135.435	-	-	-	4 365
Neponset Coal Company, . .	-	-	-	-	-	31.609	-	4 394
Frost Coal Company, . . .	-	-	-	-	-	79.986	-	4 40
Frost Coal Company, . . .	-	-	-	-	-	46.616	-	4 45
Neponset Coal Company, . .	-	-	-	-	-	43.486	-	4 48
Frost Coal Company, . . .	-	-	-	-	-	100.890	-	4 49
New England Coal and Coke Company.	-	-	-	51.167	-	-	-	4 525
Neponset Coal Company, . .	-	-	-	-	-	90.605	-	4 54
New England Coal and Coke Company.	-	-	-	144.549	-	-	-	4 55
J. F. Sheppard & Sons, . .	-	-	-	-	-	-	14.925	5 50
Total gross tons, . . .	2,296	3,193.88	1,079.24	331.151	1,821.534	393.192	584.925	-
Average price per gross ton, .	$4 007	$3 938	$3 79	$4 47	$4 094	$4 47	$4 14	-

[1] Includes adjustments for quality.

Drainage from Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham.

Five men and a foreman have been employed during the whole of the present year, the same as last year, in flushing and cleaning the

Metropolitan sewers through the tannery districts of Winchester, Woburn and Stoneham.

All of the tanneries and glue works of the district now have settling tanks of substantial size. Beggs & Cobb Company of Winchester have three duplicate sets. The present tanneries have a combined capacity of 5,900 hides per day. At the date of this report, they were handling about 2,850 hides per day. Two of the larger tanneries were closed during the year.

Table No. 1 gives details of settling tanks introduced to date and indicates that during the year about 6,500 cubic yards of semi-liquid sludge were removed from the tanks. A measurement over weirs of manufacturing wastes from large establishments in this district was made about the end of the year and indicates, as outlined in Table No. 2, that the quantity of manufacturing drainage this year does not exceed that recorded last year.

No. 1. — *Table of Semi-fluid Sludge removed from Settling Basins at the Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham.*

LOCATION OF BASIN.	Basin put in Operation.	Inside Measurement of Basin (Feet).	Number of Times cleaned during Year to Jan. 1, 1912.	Average Quantity Semi-fluid Sludge removed (Cubic Yards).	Total Quantity Semi-fluid Sludge removed to Jan. 1, 1912 (Cubic Yards).
Beggs & Cobb Company, Basin No. 1,	Jan. 15, 1910	47.0 × 23.0	15½	121	1,875
Beggs & Cobb Company, Basin No. 2,	May 9, 1910	47.0 × 23.0	5	115	575
Beggs & Cobb Company, Basin No. 3,	Oct. 19, 1911	51.0 × 25.0	1	122	122
American Hide and Leather Company, Factory E.	Aug. 1, 1910	48.3 × 23.0	7	98	686
American Hide and Leather Company, Factory D.	Nov. 15, 1910	48.0 × 23.1	None	-	-
Cottle Leather Company,	July 15, 1910	49.0 × 23.2	2	86	172
B. F. Kimball & Co.,	Dec. 10, 1910	47.2 × 23.0	4	121	484
E. Cummings Leather Company,	Nov. 1, 1910	45.9 × 22.6	4	92	368
W. P. Fox & Sons,	July 12, 1910	47.8 × 22.6	8	95	760
T. F. Boyle & Co.,	Sept. 15, 1910	48.1 × 23.1	2	87	174
Champion Tanning Company,	Jan. 9, 1911	46.8 × 22.9	4	71	284
Stoneham Tanning Company,	May 1, 1911	43.8 × 19.5	2	79	178
American Glue Company,	Oct. 1, 1910	47.1 × 23.0	2½	130	325
Winchester Manufacturing Company,	1902	35.5 × 24.7 67.2 × 12.0	7	65	455
Total,	-	-	-	-	6,458

No. 2. — *Weir Measurements of Manufacturing Drainage entering the Metropolitan Sewer from Settling Basins at Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham.*

NAME.	Weir Measurements (Gallons per 24 Hours).			Maximum Rate of Flow (Gallons per 24 Hours). 1911.	Average Rate of Flow for Nine-hour Day Period (8 A.M. to 5 P.M.) (Gallons per 24 Hours). 1911.	Estimated Per Cent. of Present Business to Maximum Capacity.	Estimated Rate of Flow for Nine-hour Day Period of Maximum Business Capacity (Gallons per 24 Hours).
	1909.	1910.	1911.				
Beggs & Cobb Company, Basin No. 1,	213,000	127,000	47,000	129,000	91,000	83⅓	-
Beggs & Cobb Company, Basin No. 2,		57,000	65,000	289,000	116,000	83⅓	-
Beggs & Cobb Company, Basin No. 3,		-	60,000	394,000	122,000	83⅓	-
American Hide and Leather Company, Factory E.	40,000[1]	40,000	41,000	79,000	61,000	89	-
American Hide and Leather Company, Factory D.	50,000[1]	2,000[1]	2,000[1]	-	2,000[1]	-[2]	-
Cottle Leather Company, . . .	50,000[1]	1,000[1]	1,000[1]	-	1,000[1]	-[2]	-
B. F. Kimball & Co., . . .	75,000[1]	75,000	25,000	70,000	50,000	66⅔	-
E. Cummings Leather Company, .	52,000[1]	52,000	38,000	144,000	79,000	80	-
W. P. Fox & Sons, ...	80,000[1]	66,000	62,000	370,000	122,000	90	-
T. F. Boyle & Co., ...	120,000[1]	116,000	56,000	186,000	108,000	75	-
Champion Tanning Company, . .	50,000[1]	38,000	47,000	225,000	76,000	45	-
Stoneham Tanning Company, . .	150,000[1]	100,000[1]	129,000	413,000[1]	251,000[1]	25	-
American Glue Company, . .	134,000	83,000	91,000	207,000	91,000	90	-
Winchester Manufacturing Company,	158,000	145,000	169,000	562,000	300,000	100	-
Total, ...	1,172,000	902,000	833,000	3,068,000	1,470,000	-	2,700,000

[1] Estimated. [2] Not tanning.

SOUTH METROPOLITAN SYSTEM.

SEWAGE LIFTING STATION AT HOUGH'S NECK, QUINCY.

During the year, the city of Quincy has connected with the Sewage Lift Works a length of about 800 feet of 18-inch pipe sewer. At the date of this report, four houses are connected with this sewer. The city expects to extend this local sewer during the coming year and take in the drainage of much of the low area in the vicinity of the lifting station.

Regular pumping was started at the lifting station April 4, 1911, and involves operating one of the 6-inch pumps for about half an hour each day. As at present operated, this involves no increase in cost of coal or labor at the Nut Island Screen-house.

SOUTH METROPOLITAN OUTFALLS.

The 60-inch outfall pipes in the harbor have been in operation seven years at the date of this report. These pipes are in normal condition and free from deposit. During the past year the average flow through them has been 42,000,000 gallons of sewage per day, with a maximum rate of 137,500,000 gallons in the month of July, 1911.

Material Intercepted at the Screens.

The material intercepted at the screens at the North Metropolitan sewerage stations, consisting of rags, paper and other floating materials, has during the year amounted to 3,714 cubic yards. This is equivalent to 5.2 cubic feet for each million gallons of sewage pumped at Deer Island.

The material intercepted at the screens at the South Metropolitan sewerage stations has amounted to 2,439 cubic yards, equal to 4.3 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers, siphons and outfall pipes indicate that they are free from deposit.

Respectfully submitted,

WILLIAM M. BROWN,
Chief Engineer of Sewerage Works.

BOSTON, January 1, 1912.

APPENDIX.

APPENDIX No. 1.

CONTRACTS MADE AND PENDING DURING

[NOTE. — The details of contracts made before

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
1	312	40-million-gallon pumping engine.	4	$105,700 00	$99,769 00[1]	Holly Mfg. Co., Buffalo, N. Y.
2	314[2]	Building pressure tunnel about 1,900 feet in length, and laying 500 feet of 80-inch steel pipe and 930 feet of 60-inch pipe in Newton, Sect. 7 of the Weston Aqueduct supply mains.	9	105,201 00	102,150 00[1]	Joseph Hanreddy, Chicago, Ill.
3	320[2]	2 vertical fire-tube boilers for Chestnut Hill Low Service Pumping Station.	4	10,640 00	10,448 00[1]	Robb-Mumford Boiler Co., Boston.
4	325[2]	27.8 tons 24-inch cast-iron water pipes; 103.4 tons special castings.	4	8,420 12	5,931 16[1]	Standard Cast Iron Pipe and Foundry Co., Bristol, Pa.
5	328[2]	Hand travelling crane, .	2	3,096 00	2,500 00[1]	Niles-Bement-Pond Co., Boston.
6	329[2]	Fuel economizer, . .	2	1,822 00	1,740 00[1]	B. F. Sturtevant Co., Boston.
7	330[2]	Hydro-electric plant at Wachusett Dam.	7[3]	71,550 00	71,500 00[1]	S. Morgan Smith Co., York, Pa.
8	331[2]	4 48-inch hydraulic lift valves.	2	6,380 00	5,068 00[1]	The Fairbanks Company, Boston.
9	332[2]	363 feet 80-inch riveted steel pipe.	4	4,270 00	3,650 00[1]	Hodge Boiler Works, East Boston.
10	333[2]	65,600 lbs. special castings, .	–[4]	–	–	Florence Iron Works, Philadelphia, Pa.
11	334[2]	35,760 lbs. special castings, .	2	1,891 70	1,430 40[1]	Davis & Farnum Mfg. Co., Waltham, Mass.
12	335[2]	54,000 lbs. special castings, .	4	1,512 00[1]	1,431 00	Builders Iron Foundry, Providence, R. I.
13	336[2]	49,800 lbs. special castings, .	5[5]	1,394 40	1,369 50	United States Cast Iron Pipe and Foundry Co., New York, N. Y.

[1] Contract based upon this bid.

[2] Contract completed.

[3] Includes separate and combined bids for hydraulic and electric plant.

APPENDIX No. 1.

THE YEAR 1911 — WATER WORKS.

1911 have been given in previous reports.]

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1911.	10. Value of Work done Dec. 31, 1911.	
Sept. 21, 1909	-	Engine in service since March 27, 1911, but not yet tested.	$99,000 00	1
Apr. 28, 1910	Nov. 25, 1911	- -	114,472 13	2
Apr. 29, 1910	Jan. 2, 1911	- -	10,448 00	3
May 18, 1910	Mar. 29, 1911	- -	5,988 45	4
Oct. 24, 1910	Feb. 10, 1911	- -	2,500 00	5
Oct. 11, 1910	May 11, 1911	- -	1,740 00	6
Dec. 8, 1910	Aug. 10, 1911	- -	68,389 62	7
Jan. 3, 1911	June 19, 1911	For each valve, $1,267, ...	5,108 00	8
Dec. 6, 1910	July 31, 1911	- -	3,725 57	9
Jan. 10, 1911	Apr. 3, 1911	For special castings, $2.55 and $4.12 per 100 pounds,	2,561 68	10
Jan. 10, 1911	Apr. 3, 1911	For special castings, $0.04 per pound, . . .	1,610 56	11
Jan. 10, 1011	Apr. 3, 1911	For special castings, $0.028 per pound, . . .	1,562 85	12
Jan. 10, 1911	Apr. 3, 1911	For special castings, $57 per ton of 2,000 pounds, .	1,340 64	13

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[4] On a portion of these castings competitive bids were not received.

[5] As lowest bidder had been awarded Contract No. 333, and next to the lowest bidder Contract No. 335 contract was awarded to third bidder in order to expedite the work.

CONTRACTS MADE AND PENDING DURING THE

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID. 4. Next to Lowest.	 5. Lowest.	6. Contractor.
1	337[2]	4 Venturi meters for Wachusett Dam.	–[6]	–	–	Builders Iron Foundry, Providence, R. I.
2	338[2]	Hydraulic turbine for Wachusett Dam.	2	$1,100 00	$1,065 00[1]	S. Morgan Smith Co., York, Pa.
3	339[2]	2,680 tons cast-iron water pipe, 60 tons special castings.	4	62,209 00	60,828 00[1]	United States Cast Iron Pipe and Foundry Co., New York, N. Y.
4	340	30 water valves; 4 24-inch, 8 20-inch, 12 16-inch, 6 12-inch valves.	3	6,434 00	5,000 00[1]	Pratt & Cady Co., Hartford, Conn.
5	341[2]	Laying 10,200 feet of 24-inch cast-iron water pipe in Boston.	5	12,343 00	11,641 50[1]	Michele Russo & Son, Boston.
6	342[2]	Cables in transmission line, Clinton Power Plant.	2	83.25 cts. per lin. ft.	77.7 cts.[1] per lin. ft.	Standard Underground Cable Co., Boston.
7	343[2]	Laying 6,700 feet of 20-inch cast-iron water pipe in Hyde Park, Mass.	7	8,446 00	8,169 00[1]	James L. Bryne, Dorchester, Mass.
8	344[2]	Laying 2,840 feet of 20-inch cast-iron water pipe with ordinary joints and 139 feet with flexible joints in Boston and Hyde Park.	3	5,469 00	4,507 60[1]	Andrew M. Cusack, Boston.
9	345[2]	2 20-inch Venturi meter tubes and 2 Type M register indicator recorders.	–[6]	–	–	Builders Iron Foundry, Providence, R. I.
10	346	2 3-million-gallon pumping engines.	Engine No. 1, 5.	7,886 00	7,525 00[1]	Laidlaw-Dunn-Gordon Co., Cincinnati, O.
			Engine No. 2, 7.	8,825 00[1]	8,738 00	
11	19-M[2]	Improvement of Lake Cochituate, surface water drains in Framingham, Natick and Wayland.	7	31,298 00	30,981 00[1]	The Henry Spinach Contracting Co., Waterbury, Conn.

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[1] Contract based upon this bid.

[2] Contract completed.

YEAR 1911 — WATER WORKS — *Continued.*

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1911.	10. Value of Work done Dec. 31, 1911.	
Jan. 26, 1911	Nov. 9, 1911	For 4 very special Venturi meters, $5,000, . .	$5,000 00	1
Mar. 6, 1911	Nov. 15, 1911	Before the contract was executed it was decided that a fly-wheel was necessary in connection with the turbine. This necessitated the use of a larger shaft. The contract price, $1,250, therefore, includes an allowance of $185 for fly-wheel and larger shaft.	1,250 00	2
May 24, 1911	Oct. 28, 1911	Straight pipe, $21.60 per ton of 2,000 pounds; special castings, $49 per ton of 2,000 pounds.	57,267 67	3
June 3, 1911	-	For whole work, $5,000, ...	4,740 00	4
June 24, 1911	Dec. 12, 1911	For laying 24-inch cast-iron pipe, $1.03 per lin. ft.; for rock excavation above and below regular grade, $6 per cu. yd.; for chamber for 24-inch valve, $45; for chambers for blow-offs and air valves, $35 per chamber; for concrete masonry, $5 per cu. yd.	15,980 35	5
June 8, 1911	June 22, 1911	For furnishing and installing 2 cables, each about 889 feet long, containing 3 No. 0, B. &. S. G. conductors, each conductor composed of 7 strands, insulated with 7/32-inch × 1/32-inch paper, laterals filled and enclosed in a pure lead sheath 1/8-inch thick, for 13,800 volts working pressure and 30,000 volts 1/2 hour factory test pressure, the sum of $0.777 per lin. ft.	1,378 10	6
July 12, 1911	Nov. 11, 1911	For laying 20-inch cast-iron pipe, $0.87 per lin. ft.; for laying 6-inch, 12-inch and 16-inch cast-iron pipe for blow-offs and connections, $1 per lin. ft.; for rock excavation above and below regular grade, $5 per cu. yd.; for earth excavation below regular grade, $1 per cu. yd.; for chambers for 20-inch valves, $50 per chamber; for chambers for 16-inch and smaller valves, $40 per chamber; for concrete masonry, $8 per cu. yd.	12,292 15	7
Aug. 28, 1911	Nov. 21, 1911	For laying 20-inch cast-iron pipe with ordinary joints, $1.24 per lin. ft., with flexible joints, under N. Y., N. H. & H. R.R., $4.95 per lin. ft.; for rock excavation above and below regular grade, $5 per cu. yd.; for earth excavation below regular grade, $1.50 per cu. yd.; for chambers for valves, $45 per chamber; for concrete masonry, $7 per cu. yd.	4,778 68	8
July 24, 1911	Aug. 23, 1911	For 20-inch Venturi meter tubes, $340 each; for Type M register indicator recorders, $400 each.	1,474 40	9
Sept. 18, 1911	-	For Engine No. 1, horizontal cross-compound, crank and fly-wheel, capacity, 3,000,000 gallons against a head of 50 feet, $7,525; for Engine No. 2, horizontal cross-compound, crank and fly-wheel, capacity, 3,000,000 gallons against a head of 140 feet, $8,825.	-	10
June 22, 1910	May 8, 1911	- -	31,067 52	11

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* Competitive bids were not received.

CONTRACTS MADE AND PENDING DURING THE

	1. Number of Contract.	2. WORK.	3. Number of Bids.	Amount of Bid. 4. Next to Lowest.	Amount of Bid. 5. Lowest.	6. Contractor.
1	20-M[2]	950 tons New River or Pocahontas coal: 250 tons for Arlington Pumping Station; 700 tons for Spot Pond Pumping Station.	3	$4.55 and $4.90 per ton.	$4.20[1] and $4.85 per ton.	New England Coal & Coke Co., Boston.
2	21-M[2]	4,000 tons Beaver Run coal for Chestnut Hill Pumping stations.	7	$3.84 per ton.	$3.83[1] per ton.	Gorman-Leonard Coal Co., Worcester, Mass.
3	23-M	1,050 tons New River or Pocahontas coal: 350 tons for Arlington Pumping Station, 700 tons for Spot Pond Pumping Station.	4[7] 3[8]	$3.88 and $4.68, July to Apr., $4.78 Apr. to July per ton.	$3.80[1] and $4.35 per ton.	New England Coal and Coke Co., Boston.
4	24-M	5,500 tons Beaver Run coal for Chestnut Hill Pumping stations.	10	$3.79 [1] per ton.	$3.75 per ton.	Gorman-Leonard Coal Co., Worcester, Mass.
5	Special[2] Order.	Erecting boilers at Chestnut Hill Pumping Station.	2	660 00	600 00[1]	F. Knight & Son, Boston.
6	Special[2] Order.	2 smoke flues at Chestnut Hill Pumping Station.	4	555 00	536 00[1]	B. F. Sturtevant Co., Boston.
7	Special[2] Order.	Special castings, . . .	5	1,092 12	958 00[1]	Warren Foundry & Machine Co., New York, N. Y.
8	Special[2] Order.	Furnishing and applying non-conducting covering to boilers, smoke flue and steam piping, Chestnut Hill Pumping Station.	4	755 00	739 00[1]	Philip Carey Co., Boston.
9	Special[2] Order.	Governor for exciter wheel of Power Plant at Wachusett Dam.	–[6]	-	-	Lombard Governor Co., Ashland, Mass.
10	Special[2] Order.	Furnishing and placing sheraduct iron conduit in floor of Power House at Wachusett Dam.	2	730 58	651 23[1]	M. B. Foster Electric Co., Boston.
11	Special[2] Order.	400-gallon power sprayer, .	–[6]	-	-	Fitzhenry-Guptill Co., Boston.

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[1] Contract based upon this bid.

[2] Contract completed.

Year 1911 — Water Works — *Continued.*

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1911.	10. Value of Work done Dec. 31, 1911.	
July 25, 1910	Apr. 25, 1911	- -	$3,428 48	1
Aug. 18, 1910	May 16, 1911	- -	16,689 81	2
July 8, 1911	-	$3.80 per ton of 2,240 pounds delivered on cars at the Arlington Pumping Station; $4.35 per ton of 2,240 pounds delivered in bins at the Spot Pond Pumping Station.	3,090 25	3
Oct. 24, 1911	-	$3.79 per ton of 2,240 pounds delivered on cars at Chestnut Hill Pumping stations, until Nov. 15, 1912, and $3.83 per ton of 2,240 pounds after that date.	4,809 59	4
Dec. -, 1910	Feb. 2, 1911	- -	600 00	5
Dec. 23, 1910	Feb. 17, 1911	- -	499 88	6
Feb. 27, 1911	Apr. 12, 1911	For special castings 2½ cents per pound, . .	1,034 60	7
Mar. 6, 1911	Mar. 31, 1911	For whole work, $739, ...	739 00	8
Mar. 15, 1911	May 15, 1911	For whole work, $753.50, ...	753 50	9
Mar. 18, 1911	May 25, 1911	Sheraduct iron conduit and fittings, $594.49; labor, $330.61; express, $0.40.	925 50	10
May 12, 1911	May 23, 1911	For platform wagon, $300, pump, $410; valve, $12; engine, $355.50; long nozzle, $10; assembling and freight, $19.	1,106 50	11
			$487,353 48	

[6] Competitive bids were not received.

[7] Arlington Station.

[8] Spot Pond Station.

CONTRACTS MADE AND PENDING DURING THE YEAR 1911 — WATER WORKS — *Concluded.*

Summary of Contracts.[1]

	Value of Work done Dec. 31, 1911.
Wachusett Department, 10 contracts,	$90,701 45
Distribution Department, 13 contracts,	331,907 40
319 contracts completed from 1896 to 1910, inclusive,	16,391,984 45
	$16,814,593 30
Deduct for work done on 11 Sudbury Reservoir contracts by the City of Boston,	512,000 00
Total of 352 contracts,	$16,302,593 30

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[1] In this summary contracts charged to maintenance are excluded.

APPENDIX No. 2.

TABLE No. 1. — *Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1911.*

	PLACE.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Wachusett Watershed.	Princeton,	2.78	2.06	3.54	1.76	1.76	2.08	2.14	5.53	3.04	5.49	3.87	2.89	36.94
	Jefferson,	3.19	2.63	4.11	2.42	1.91	2.24	2.70	5.83	3.08	5.79	4.11	3.06	41.07
	Sterling,	2.72	2.29	3.60	2.12	1.26	2.40	2.12	5.27	3.00	5.22	4.41	3.01	37.42
	Boylston,	2.93	2.75	3.92	2.56	1.44	2.77	3.14	5.21	3.03	4.46	4.17	3.09	39.47
Sudbury Watershed.	Sudbury Dam,	2.78	2.78	3.50	2.49	0.72	2.47	3.35	4.26	2.46	3.70	4.59	3.32	36.42
	Framingham,	2.75	2.64	3.33	2.80	0.72	2.42	3.21	4.66	2.73	3.57	4.39	3.63	36.85
	Ashland Dam,	2.80	2.74	3.57	2.96	1.05	2.37	2.98	5.15	2.67	3.45	4.61	3.67	38.02
	Cordaville,	3.19	2.92	3.96	3.01	1.55	2.84	3.21	5.68	3.12	4.05	4.89	3.80	42.22
Lake Cochituate,		2.74	3.20	3.31	2.73	0.65	2.53	3.42	4.82	2.96	3.53	4.28	3.74	37.91
Chestnut Hill Reservoir,		3.05	3.43	3.27	2.55	0.58	3.84	4.69	5.01	3.59	3.22	4.40	3.65	41.28
Spot Pond,		2.78	3.18	3.47	2.45	1.01	3.69	6.30	4.52	3.34	2.93	4.02	3.72	41.41
	Average of all,	2.88	2.78	3.60	2.53	1.15	2.70	3.39	5.08	3.00	4.13	4.34	3.42	39.00
	Average, Wachusett watershed,	2.91	2.43	3.79	2.22	1.50	2.37	2.53	5.46	3.04	5.24	4.14	3.01	38.73
	Average, Sudbury watershed,	2.88	2.77	3.59	2.81	1.01	2.53	3.19	4.94	2.75	3.69	4.62	3.60	38.38

TABLE No. 2. — *Rainfall in Inches at Jefferson, Mass., in 1911.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	[2]	–	–	–	0.09	–	–	–	–	[2]	0.14	–
2,	[2]	0.41[3]	–	–	–	–	–	–	–	0.64	–	–
3,	1.26	–	–	–	–	–	–	–	–	–	–	–
4,	–	1.14[3]	–	[2]	–	–	–	–	–	0.44	–	–
5,	–	–	–	[2]	–	[2]	–	–	–	–	–	–
6,	0.05[1]	–	0.23[1]	1.42[3]	–	[2]	0.56	–	0.29	[2]	[2]	–
7,	–	0.61[1]	–	–	–	1.56	–	–	–	0.54[3]	0.63	–
8,	0.20	0.07[1]	–	–	–	–	–	–	[2]	–	–	–
9,	–	–	–	0.52[1]	–	–	–	–	0.71	0.38	–	–
10,	–	–	0.27[1]	–	–	–	–	–	–	–	0.09	–
11,	0.05	–	–	–	–	–	–	–	0.09	–	–	–
12,	[2]	–	–	–	–	[2]	–	–	–	–	0.40	–
13,	[2]	0.12	–	–	–	0.68	–	–	–	–	–	–
14,	0.19	–	–	0.27	–	–	–	–	–	–	[2]	–
15,	0.07[3]	–	1.05[1]	–	–	–	–	1.88	0.50	0.20	0.90[3]	[2]
16,	–	–	–	–	–	–	–	–	–	–	–	[2]
17,	–	0.04	–	–	–	–	0.17	0.06	–	[2]	–	0.98[3]
18,	–	–	0.24[3]	–	–	–	–	0.44	–	[2]	0.94	–
19,	–	–	0.68[1]	–	0.83	–	–	–	–	[2]	–	–
20,	–	0.24[1]	0.08	0.21[1]	–	–	0.10	–	–	[2]	0.08[1]	–
21,	0.05	–	–	–	–	–	–	–	[2]	[2]	–	–
22,	–	–	–	–	–	–	0.08	–	0.44	[2]	–	[2]
23,	–	–	–	–	0.17	–	–	–	–	3.54	–	1.23
24,	–	–	–	–	–	–	0.85	–	–	–	0.75	–
25,	–	–	–	–	0.46	–	–	[2]	0.26	–	–	–
26,	[2]	–	–	–	–	–	–	0.48	–	–	–	–
27,	1.06[3]	–	[2]	–	–	–	–	[2]	0.19	0.05	–	0.30
28,	–	–	0.80	–	–	–	0.94	[2]	–	–	0.18	–
29,	0.26[3]	–	[2]	–	–	–	–	1.84	0.60	–	–	–
30,	–	–	0.76	–	–	–	–	–	–	–	–	[2]
31,	–	–	–	–	0.36	–	–	1.13	–	–	–	0.55[3]
Totals,	3.19	2.63	4.11	2.42	1.91	2.24	2.70	5.83	3.08	5.79	4.11	3.06

Total for the year 41.07 inches.

[1] Snow. [2] Rainfall included in that of following day. [3] Rain and snow.

TABLE No. 3. — *Rainfall in Inches at Framingham, Mass., in 1911.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1, ...	[2]	[2]	–	–	–	–	–	0.01	–	[2]	0.05	–
2, ...	[2]	0.35[3]	–	–	–	–	–	–	–	0.61	–	–
3, ...	[2]	[2]	0.02[1]	–	–	–	–	–	–	[2]	–	–
4, ...	1.17[3]	1.14[3]	–	[2]	–	–	–	–	–	0.35	–	–
5, ...	–	–	–	1.48[3]	–	[2]	–	–	–	–	–	–
6, ...	–	[2]	0.14[1]	–	–	[2]	0.23	–	0.35	[2]	[2]	–
7, ...	–	0.63[1]	–	–	–	1.60	–	–	–	0.53	0.35	–
8, ...	0.20	0.07[1]	–	–	0.04	–	–	–	–	–	–	–
9, ...	–	–	–	0.67[1]	0.02	–	–	–	0.58	–	–	0.04
10, ...	–	–	0.16[3]	–	–	0.05	–	–	–	–	0.13	–
11, ...	0.10	–	–	–	–	[2]	–	–	0.17	–	–	–
12, ...	–	–	0.06	–	–	[2]	–	–	–	–	0.51	–
13, ...	0.11	[2]	–	–	–	[2]	–	–	–	–	–	–
14, ...	0.07	0.09[1]	–	0.12	–	0.61	–	–	–	–	[2]	[2]
15, ...	0.02[1]	–	0.98[3]	–	–	–	–	0.41	[2]	[2]	0.91[3]	[2]
16, ...	–	–	–	0.03[1]	–	0.08	–	0.04	0.44	0.04	–	[2]
17, ...	–	[2]	–	–	–	–	0.09	–	–	0.05	–	1.01[3]
18, ...	–	0.08	0.25	–	–	–	–	0.62	–	[2]	0.97	0.01[1]
19, ...	–	–	0.58[3]	[2]	0.32	–	–	–	–	0.84	–	–
20, ...	–	0.27[1]	–	0.37	–	0.04	0.04	–	–	–	[2]	–
21, ...	–	–	–	–	–	–	–	–	[2]	[2]	0.03[3]	–
22, ...	0.01[1]	0.01[1]	0.03	[2]	–	0.02	–	–	0.14	[2]	–	[2]
23, ...	–	–	–	0.03[3]	0.02	–	–	–	–	0.94	–	1.73
24, ...	–	–	–	–	0.02	–	0.85	[2]	–	–	[2]	–
25, ...	–	–	–	–	0.15	–	–	[2]	0.30	–	1.06	–
26, ...	0.14	–	[2]	–	–	0.02	–	[2]	0.17	–	–	[2]
27, ...	[2]	–	[2]	–	–	–	–	[2]	0.04	0.04	–	0.27
28, ...	0.81	–	0.48	–	–	–	2.00	1.04	–	–	0.38	–
29, ...	[2]	–	[2]	–	–	–	–	[2]	0.54	–	–	–
30, ...	0.12[3]	–	0.63	0.10	–	–	–	[2]	–	–	–	[2]
31, ...	–	–	–	–	0.15	–	–	2.54	–	0.17	–	0.57[3]
Totals, ...	2.75	2.64	3.33	2.80	0.72	2.42	3.21	4.66	2.73	3.57	4.39	3.63

Total for the year 36.85 inches.

[1] Snow. [2] Rainfall included in that of following day. [3] Rain and snow.

TABLE NO. 4.—*Rainfall in Inches at Chestnut Hill Reservoir in 1911.*

DATE.	Amount.	Duration.
Jan. 1, . .	.51	6.00 P.M. to 8.00 A.M.
Jan. 2, . .		
Jan. 3, . .	.98[2]	5.00 A.M. to 6.45 A.M.
Jan. 4, . .		
Jan. 8, . .	.28	9.30 P.M. to 2.05 A.M.
Jan. 9, . .		
Jan. 11, . .	.14	9.45 P.M. to 1.25 A.M.
Jan. 12, . .		
Jan. 13, . .	.15	1.00 P.M. to 7.30 P.M.
Jan. 14, . .		
Jan. 26, . .	.16[2]	5.00 P.M. to 7.00 P.M.
Jan. 27, . .	.74	10.30 A.M. to 6.10 A.M.
Jan. 28, . .		
Jan. 29, . .	.09[2]	5.00 P.M. to 11.00 P.M.
Total, .	3.05	
Feb. 2, . .	.52[1]	4.50 A.M. to 2.50 A.M.
Feb. 3, . .		
Feb. 3, . .	1.11[2]	7.45 A.M. to 1.30 P.M.
Feb. 4, . .		
Feb. 6, . .	.94[1]	4.00 P.M. to 4.00 P.M.
Feb. 7, . .		
Feb. 8, . .	.11[1]	2.30 P.M. to 9.40 P.M.
Feb. 13, . .	.25[1]	2.30 P.M. to 1.10 P.M.
Feb. 14, . .		
Feb. 17, . .	.18[2]	11.45 A.M. to 6.00 P.M.
Feb. 20, . .	.32[1]	8.15 A.M. to 11.55 P.M.
Total, .	3.43	
Mar. 3, . .	.03[1]	6.30 P.M. to 8.30 P.M.
Mar. 6, . .	.18[1]	5.05 A.M. to 9.30 P.M.
Mar. 10, . .	.21	8.20 A.M. to 4.00 P.M.
Mar. 12, . .	.08	1.10 P.M. to 8.10 P.M.
Mar. 15, . .	.86	2.05 A.M. to 10.00 A.M.
Mar. 16, . .	.14[1]	12.05 A.M. to 5.05 A.M.
Mar. 18, . .	.15	6.10 A.M. to 12.30 P.M.
Mar. 19, . .	.52[2]	6.30 P.M. to 12.05 A.M.
Mar. 20, . .		
Mar. 27, . .	.49	3.15 A.M. to 3.15 A.M.
Mar. 28, . .		
Mar. 29, . .	.61	7.00 P.M. to 2.50 A.M.
Mar. 30, . .		
Total, .	3.27	
Apr. 4, . .	1.40	5.30 P.M. to 10.45 P.M.
Apr. 5, . .		
Apr. 9, . .	.60[1]	1.55 A.M. to 1.15 P.M.
Apr. 14, . .	.12	5.00 P.M. to 11.30 P.M.
Apr. 19, . .	.35	3.30 P.M. to 12.25 P.M.
Apr. 20, . .		
Apr. 30, . .	.08	9.00 A.M. to 7.00 A.M.
May 1, . .		
Total, .	2.55	
May 8, . .	.09	10.50 P.M. to 12.25 A.M.
May 9, . .		
May 9, . .	.04	7.00 P.M. to 12.35 A.M.
May 10, . .		
May 19, . .	.04	5.35 A.M. to 7.30 A.M.
May 24, . .	.12	1.35 A.M. to 2.05 A.M.
May 25, . .	.18	7.30 A.M. to 3.30 P.M.
May 31, . .	.11	9.30 A.M. to 5.35 A.M.
June 1, . .		
Total, .	.58	
June 5, .	2.58	4.45 P.M. to 8.00 A.M.
June 7, .		
June 10, .	.11	4.35 P.M. to 10.25 P.M.
June 11, .	.96	6.00 P.M. to 5.00 P.M.
June 13, .		
June 16, .	.13	12.15 P.M. to 4.30 P.M.
June 20, .	.06	8.15 A.M. to 7.00 P.M.
Total, .	3.84	
July 6, . .	.18	7.30 P.M. to 11.00 P.M.
July 24, . .	.86	9.10 A.M. to 1.10 A.M.
July 25, . .		
July 28, . .	3.65	2.50 A.M. to 8.30 P.M.
Total, .	4.69	
Aug. 15, .	.51	5.00 P.M. to 11.50 P.M.
Aug. 17, .	.05	4.00 A.M. to 4.40 A.M.
Aug. 18, .	.48	2.45 P.M. to 8.00 P.M.
Aug. 24, .	.25	11.00 P.M. to 8.00 A.M.
Aug. 26, .		
Aug. 27, .	.89	4.50 A.M. to 6.15 A.M.
Aug. 28, .		
Aug. 28, .	.23	12.40 P.M. to 1.05 P.M.
Aug. 29, .	1.32	2.00 A.M. to 11.20 A.M.
Aug. 30, .		
Aug. 31, .	1.28	12.05 A.M. to 9.30 P.M.
Total, .	5.01	
Sept. 6, .	.20	7.05 A.M. to 11.05 A.M.
Sept. 9, .	.47	8.35 A.M. to 4.30 P.M.
Sept. 11, .	.14	10.00 A.M. to 2.00 P.M.
Sept. 15, .	.54	2.30 P.M. to 5.45 A.M.
Sept. 16, .		
Sept. 22, .	.16	2.45 A.M. to 7.30 A.M.
Sept. 25, .	1.58	5.40 P.M. to 10.15 A.M.
Sept. 26, .		
Sept. 27, .	.06	6.30 P.M. to 8.45 P.M.
Sept. 29, .	.44	7.45 A.M. to 8.15 P.M.
Total, .	3.59	

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[1] Snow.

[2] Rain and snow.

TABLE No. 4. — *Rainfall in Inches at Chestnut Hill Reservoir in 1911* — Concluded.

DATE.	Amount.	Duration.
Oct. 1, . .	.67	5.30 P.M. to
Oct. 2, . .		10.30 A.M.
Oct. 4, . .	.04	6.35 A.M. to 7.00 A.M.
Oct. 4, . .	.42	9.45 A.M. to 10.00 P.M.
Oct. 6, . .	.55	7.50 P.M. to
Oct. 7, . .		10.30 A.M.
Oct. 15, . .	.15	12.50 P.M. to 6.15 P.M.
Oct. 17, . .	.06	10.45 A.M. to 8.45 P.M.
Oct. 18, . .	.37	8.45 A.M. to
Oct. 19, . .		12.25 A.M.
Oct. 19, . .	.03	1.30 P.M. to 4.00 P.M.
Oct. 21, . .	.68	9.30 A.M. to
Oct. 23, . .		8.00 A.M.
Oct. 27, . .	.04	3.30 P.M. to 8.20 P.M.
Oct. 31, . .	.21	10.30 A.M. to
Nov. 1, . .		8.00 A.M.
Total, .	3.22	
Nov. 1, .	.05	8.00 A.M. to 11.30 P.M.
Nov. 6, .	.35	6.00 P.M. to
Nov. 7, .		5.00 A.M.
Nov. 10, .	.13	4.00 A.M. to 6.00 P.M.
Nov. 12, .	.50	8.10 P.M. to 11.50 P.M.
Nov. 14, .	.85[2]	9.45 P.M. to
Nov. 15, .		8.00 A.M.
Nov. 18, .	1.01[2]	12.20 A.M. to 1.00 P.M.
Nov. 20, .	.03	3.25 P.M. to 5.40 P.M.
Nov. 24, .	.83	6.35 A.M. to
Nov. 25, .		3.15 A.M.
Nov. 28, .	.65	2.00 P.M. to
Nov. 29, .		12.45 A.M.
Total, .	4.40	
Dec. 9, . .	.06	11.30 A.M. to 4.00 P.M.
Dec. 15, . .	1.03[2]	2.30 A.M. to
Dec. 17, . .		8.00 A.M.
Dec. 22, . .	1.80	4.20 P.M. to
Dec. 23, . .		6.45 A.M.
Dec. 26, . .	.21	10.45 P.M. to
Dec. 27, . .		10.50 A.M.
Dec. 31, . .	.35[1]	4.00 A.M. to 12.45 P.M.
Dec. 31, . .	.20	1.15 P.M. to 11.00 P.M.
Total, .	3.65	

Total for year 41.28 inches.

[1] Snow.

[2] Rain and snow.

TABLE No. 5. — *Rainfall in Inches on the Wachusett Watershed,*[1] *1897 to 1911.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1897,	3.46	2.86	4.01	2.32	5.06	5.11	8.65	3.47	1.93	0.94	7.62	6.41	51.84
1898,	6.65	3.30	2.27	4.43	3.38	3.11	3.01	10.61	3.15	7.21	6.81	3.99	57.92
1899,	2.93	5.12	6.75	1.94	1.33	5.51	3.82	3.20	4.11	2.72	1.94	2.03	41.40
1900,	4.56	8.69	6.19	2.76	4.34	3.59	3.20	3.18	3.46	2.90	6.44	3.15	52.46
1901,	1.75	1.13	5.82	9.64	7.02	1.51	5.66	4.58	3.10	3.70	2.43	9.36	55.70
1902,	2.72	4.91	5.27	4.36	2.24	2.51	3.87	3.95	4.26	6.36	0.93	7.20	48.58
1903,	2.85	4.42	6.58	3.10	1.24	10.37	3.43	3.88	2.93	4.43	2.36	3.99	49.58
1904,	4.02	2.66	3.40	7.45	2.99	3.44	3.84	3.68	5.30	1.78	1.62	2.88	43.06
1905,	6.10	1.72	3.95	2.60	0.83	4.88	5.39	3.09	6.90	1.81	2.52	3.79	43.58
1906,	2.59	2.74	5.17	3.12	6.58	5.95	5.52	4.34	2.61	3.95	2.25	4.26	49.08
1907,	2.84	2.32	1.82	2.65	2.96	3.54	3.03	1.26	9.50	5.68	5.74	4.40	45.74
1908,	3.40	4.82	2.77	2.62	5.34	1.29	3.85	6.49	1.04	2.13	1.05	3.03	37.83
1909,	3.52	6.10	4.38	5.71	2.65	3.03	4.25	3.59	3.90	1.70	1.68	3.99	44.50
1910,	5.86	5.24	1.09	3.01	2.13	4.36	1.52	3.87	2.86	1.40	4.17	2.34	37.85
1911,	2.91	2.43	3.79	2.22	1.59	2.37	2.53	5.46	3.04	5.24	4.14	3.01	38.73
Totals,	56.16	58.46	63.26	57.93	49.68	60.57	61.57	64.65	58.09	51.96	51.70	63.83	697.85
Average (15 years),	3.74	3.90	4.22	3.86	3.31	4.04	4.11	4.31	3.87	3.46	3.45	4.26	46.53

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[1] Means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December 1911, Princeton, Jefferson, Sterling and Boylston.

TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed,*[1] *1875 to 1911.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875,	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49
1876,	1.83	4.21	7.43	4.20	2.76	2.04	9.13	1.72	4.62	2.24	5.76	3.62	49.56
1877,	3.22	0.74	8.36	3.43	3.70	2.43	2.95	3.68	0.32	8.52	5.80	0.87	44.02
1878,	5.63	5.97	4.69	5.79	0.96	3.88	2.97	6.94	1.29	6.42	7.02	6.37	57.93
1879,	2.48	3.56	5.14	4.72	1.58	3.79	3.93	6.51	1.88	0.81	2.68	4.34	41.42
1880,	3.57	3.98	3.31	3.11	1.84	2.14	6.27	4.01	1.60	3.74	1.78	2.83	38.18
1881,	5.56	4.65	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96	44.17
1882,	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30	39.40
1883,	2.81	3.87	1.78	1.84	4.19	2.40	2.68	0.73	1.52	5.60	1.81	3.55	32.78
1884,	5.09	6.54	4.72	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	5.17	47.14
1885,	4.71	3.87	1.07	3.60	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.72	43.54
1886,	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97	46.06
1887,	5.20	4.78	4.90	4.27	1.16	2.65	3.76	5.28	1.32	2.83	2.67	3.88	42.70
1888,	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.99	7.22	5.40	57.47
1889,	5.37	1.65	2.37	3.41	2.95	2.80	8.94	4.18	4.60	4.25	6.29	3.14	49.95
1890,	2.53	3.51	7.73	2.64	5.21	2.03	2.46	3.87	6.00	10.51	1.20	5.31	53.00
1891,	7.02	5.23	6.48	3.91	2.01	3.77	3.39	4.73	2.38	3.83	3.09	3.68	49.52
1892,	5.85	3.14	4.06	0.83	5.58	2.76	4.23	4.44	2.84	1.17	5.80	1.13	41.83
1893,	2.92	8.20	3.67	3.60	6.61	2.38	2.57	5.41	1.74	4.07	2.20	4.86	48.23
1894,	4.09	3.91	1.43	3.42	4.24	1.15	3.26	2.03	2.63	5.34	3.43	4.81	39.74

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[1] See note at bottom of page 174.

TABLE NO. 6. — *Rainfall in Inches on the Sudbury Watershed,*[1] *1875 to 1911* — Concluded.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1895,	4.06	1.39	2.98	5.25	2.02	2.77	5.04	4.15	2.30	10.68	6.63	3.35	50.62
1896,	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12	43.70
1897,	4.00	2.91	3.66	2.82	4.37	4.46	5.44	3.51	2.94	0.47	6.40	5.21	46.19
1898,	6.83	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.62	6.71	6.93	3.28	55.88
1899,	4.18	4.91	7.01	1.90	1.45	2.51	3.22	1.43	3.95	2.69	2.18	1.78	37.21
1900,	4.96	9.14	6.35	2.58	4.32	2.99	2.42	2.26	3.36	3.83	5.70	2.74	50.65
1901,	1.82	1.52	6.57	8.60	7.23	1.38	5.71	4.57	3.30	2.82	2.90	9.69	56.11
1902,	2.52	6.18	5.34	4.13	1.86	2.89	2.94	3.40	4.54	4.44	1.45	6.38	46.07
1903,	3.80	3.95	6.63	2.99	0.93	9.25	2.77	3.67	1.75	4.72	1.56	3.14	45.16
1904,	4.87	3.00	2.72	8.87	2.65	2.80	1.96	3.86	5.80	1.64	1.73	2.92	42.82
1905,	5.26	2.20	3.15	2.72	1.31	5.00	5.47	2.70	6.88	1.54	2.07	4.01	42.31
1906,	2.47	2.92	6.32	2.88	5.66	3.91	3.42	3.02	3.30	3.40	2.69	4.49	44.48
1907,	3.28	2.17	1.91	3.41	3.63	3.53	1.86	1.07	8.76	4.17	6.12	4.47	44.38
1908,	3.60	4.56	3.82	1.88	5.51	0.86	3.71	4.57	0.97	2.55	0.98	3.14	36.15
1909,	3.98	5.79	4.26	4.67	2.43	2.81	1.59	2.93	4.74	1.12	3.38	4.05	41.75
1910,	5.39	5.06	0.85	2.75	1.29	4.68	2.03	2.62	2.49	1.86	4.13	2.49	35.64
1911,	2.88	2.77	3.59	2.81	1.01	2.53	3.19	4.94	2.75	3.69	4.62	3.60	38.38
Totals,	153.05	155.61	161.69	129.37	121.16	115.90	131.38	143.51	129.47	145.09	142.69	140.71	1,669.63
Average (37 years),	4.14	4.21	4.37	3.50	3.27	3.13	3.55	3.88	3.50	3.92	3.86	3.80	45.13

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[1] Means of observations at several places, as follows: January, 1875, to April, 1876, Lake Cochituate; April to June, 1876, Lake Cochituate, Westborough and Hopkinton; June to December, 1876, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to January, 1883, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to January, 1884, Framingham and Southborough; January, 1884, to January, 1890, Framingham and Westborough; January, 1890, to May, 1898, Framingham and Ashland Dam; June, 1898, to December, 1911, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

TABLE No. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile*[1] *from 1897 to 1911.*

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	Mean for 15 Years, 1897-1911.
January, . .	796,000	1,563,000	2,092,000	796,000	519,000	1,676,000	1,265,000	659,000	1,266,000	1,132,000	1,458,000	1,738,000	592,000	1,846,000	773,000	1,212,000
February, . .	931,000	1,635,000	1,090,000	4,054,000	356,000	1,401,000	2,133,000	927,000	452,000	1,027,000	692,000	1,736,000	2,556,000	1,845,000	625,000	1,430,000
March, . .	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000	3,992,000	3,423,000	3,008,000	3,004,000	1,860,000	1,697,000	2,192,000	2,129,000	2,640,000	1,339,000	2,690,000
April, . .	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000	2,238,000	2,984,000	1,617,000	2,109,000	1,436,000	1,269,000	2,422,000	1,034,000	1,393,000	2,151,000
May, . . .	1,163,000	1,390,000	862,000	1,382,000	2,729,000	1,031,000	569,000	1,498,000	445,000	1,533,000	965,000	1,415,000	1,212,000	608,000	461,000	1,151,000
June, . . .	1,181,000	828,000	561,000	578,000	985,000	410,000	2,131,000	762,000	542,000	1,184,000	773,000	403,000	632,000	824,000	351,000	810,000
July, . . .	1,442,000	333,000	354,000	217,000	477,000	292,000	624,000	497,000	365,000	728,000	335,000	220,000	233,000	62,000	57,000	416,000
August, . .	896,000	1,325,000	236,000	197,000	512,000	297,000	474,000	355,000	321,000	591,000	87,000	443,000	193,000	186,000	188,000	420,000
September, .	380,000	676,000	250,000	127,000	320,000	241,000	375,000	494,000	1,228,000	277,000	810,000	88,000	208,000	145,000	181,000	387,000
October, . .	243,000	1,509,000	245,000	282,000	647,000	950,000	689,000	347,000	367,000	530,000	1,382,000	158,000	90,000	68,000	718,000	548,000
November, .	1,283,000	2,170,000	430,000	875,000	517,000	635,000	634,000	343,000	442,000	749,000	2,540,000	125,000	363,000	354,000	1,035,000	833,000
December, .	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,848,000	954,000	440,000	1,018,000	794,000	1,961,000	387,000	537,000	391,000	1,067,000	1,260,000
Average, .	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000	1,285,000	1,025,000	926,000	1,043,000	1,180,000	847,000	918,000	828,000	682,000	1,107,000
Average driest six months,	886,000	1,013,000	312,000	377,000	576,000	471,000	626,000	413,000	541,000	613,000	725,000	238,000	270,000	201,000	327,000	567,000

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[1] The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, 2.4 per cent. in 1903, 3.6 per cent. in 1904, 4.1 per cent. in 1905, 5.1 per cent. in 1906, 6.0 per cent. in 1907, 7.0 per cent. in 1908, 1909 and 1910, and 6.5 per cent. in 1911.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1911.*

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.
January, ...	103,000	643,000	658,000	1,810,000	700,000	1,120,000	415,000	1,241,00	335,000	995,000	1,235,000	1,461,000	2,589,000
February, ...	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,403,000	1,033,000	2,842,000	1,354,000	4,801,000	2,829,000
March, ...	1,604,000	4,435,000	4,814,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000	2,059,000	2,868,000
April, ...	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,169,000	1,546,000	867,000	1,350,000	2,853,000	1,815,000	1,947,000	2,620,000
May, ...	1,188,000	1,138,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000	937,000	1,030,000	1,336,000	720,000	1,009,000
June, ...	870,000	222,000	597,000	506,000	413,000	175,000	1,338,000	529,000	300,000	416,000	426,000	203,000	413,000
July, ...	321,000	183,000	202,000	128,000	157,000	176,000	276,000	86,000	115,000	224,000	62,000	116,000	115,000
August, ...	396,000	405,000	121,000	476,000	395,000	119,000	148,000	55,000	79,000	257,000	240 000	94,000	214,000
September, ...	207,000	184,000	60,000	161,000	141,000	80,000	197,000	307,000	91,000	44,000	121,000	117,000	111,000
October, ...	646,000	234,000	631,000	516,000	71,000	102,000	186,000	299,000	186,000	83,000	336,000	146,000	190,000
November, ...	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	209,000	205,000	175,000	1,177,000	673,000	369,000
December, ...	584,000	453,000	1,290,000	3,177,000	463,000	175,000	775,000	315,000	194,000	925,000	1,174,000	1,020,000	643,000
Average, ...	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000	533,000	1,129,000	901,000	1,087 000	1,154,000
Average, driest six months, .	574,000	384,000	502,000	532,000	230,000	143,000	330,000	211,000	145,000	200,000	391,000	223,000	234,000

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[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1911* — Continued.

MONTH.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.
January,	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000	434,000	693,000	1,034,000	1,084,000	845,000	1,638,000	2,288,000	794,000
February,	1,950,000	1,196,000	1,529,000	3,486,000	943,000	1,542,000	991,000	541,000	2,676,000	1,067,000	3,022,000	1,381,000	3,800,000
March,	3,238,000	1,338,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000	3,835,000	2,565,000	2,604,000	4,205,000	3,654,000
April,	2,645,000	1,410,000	1,875,000	2,307,000	871,000	2,125,000	1,640,000	2,515,000	1,494,000	1,515,000	1,829,000	2,521,000	1,350,000
May,	1,632,000	880,000	1,366,000	583,000	1,259,000	2,883,000	840,000	636,000	360,000	915,000	1,246,000	511,000	1,312,000
June,	421,000	653,000	568,000	413,000	428,000	440,000	419,000	174,000	399,000	962,000	530,000	66,000	316,000
July,	117,000	634,000	107,000	149,000	214,000	158,000	161,000	231,000	95,000	658,000	231,000	19,000	—18,000
August,	379,000	1,432,000	132,000	163,000	280,000	181,000	209,000	229,000	57,000	591,000	1,107,000	—35,000	—34,000
September,	1,155,000	823,000	457,000	203,000	229,000	108,000	150,000	89,000	388,000	182,000	369,000	94,000	65,000
October,	1,999,000	1,230,000	2,272,000	210,000	126,000	222,000	374,000	1,379,000	592,000	94,000	1,160,000	115,000	186,000
November,	2,758,000	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000	659,000	909,000	1,986,000	304,000	663,000
December,	3,043,000	2,241,000	906,000	544,000	485,000	796,000	716,000	1,782,000	657,000	1,584,000	1,799,000	220,000	1,096,000
Average	1,697,000	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000	991,000	1,450,000	973,000	1,082,000
Average, driest six months,	953,000	944,000	747,000	239,000	327,000	237,000	356,000	460,000	314,000	564,000	777,000	93,000	194,000

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[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894, and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1911* — Concluded.

MONTH.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	Mean for 37 Years, 1875-1911.
January,	437,000	1,763,000	1,736,000	477,000	1,410,000	1,128,000	1,351,000	1,925,000	392,000	1,490,000	519,000	1,209,000
February,	300,000	1,674,000	2,279,000	882,000	330,000	1,041,000	624,000	1,536,000	2,286,000	1,849,000	700,000	1,735,000
March,	2,755,000	4,199,000	3,454,000	2,999,000	2,497,000	2,409,000	1,658,000	2,257,000	1,734,000	1,954,000	1,144,000	2,791,000
April,	4,204,000	1,885,000	2,261,000	3,294,000	1,643,000	1,949,000	1,607,000	1,117,000	1,721,000	667,000	1,426,000	1,989,000
May,	2,954,000	743,000	351,000	1,745,000	297,000	1,059,000	888,000	1,046,000	1,004,000	277,000	318,000	1,058,000
June,	753,000	303,000	1,987,000	419,000	467,000	707,000	761,000	194,000	239,000	516,000	213,000	507,000
July,	306,000	66,000	445,000	62,000	177,000	398,000	9,000	—14,000	—121,000	—102,000	—14,000	166,000
August,	424,000	135,000	307,000	170,000	114,000	180,000	—104,000	102,000	—45,000	—73,000	20,000	241,000
September,	305,000	178,000	130,000	397,000	1,246,000	19,000	541,000	—82,000	149,000	5,000	76,000	246,000
October,	412,000	506,000	492,000	191,000	158,000	301,000	741,000	47,000	—51,000	—51,000	296,000	449,000
November,	474,000	444,000	363,000	289,000	279,000	483,000	1,998,000	71,000	82,000	176,000	593,000	804,000
December,	2,695,000	1,779,000	582,000	269,000	887,000	659,000	2,032,000	136,000	263,000	221,000	908,000	1,016,000
Average	1,342,000	1,140,000	1,190,000	931,000	795,000	860,000	1,010,000	694,000	625,000	570,000	514,000	1,013,000
Average, driest six months,	445,000	271,000	388,000	228,000	403,000	341,000	471,000	44,000	40,000	29,000	151,000	400,000

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[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

NOTE. — The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, particularly during months of small yield, due to unavoidable inaccuracies in the measurement of large quantities of water received from the Wachusett Reservoir.

TABLE NO. 9. — *Wachusett System. — Statistics of Flow of Water, Storage and Rainfall in 1911.*

[Watershed above dam = 118.19 square miles.]

MONTH.	GALLONS PER DAY.									
	Discharged into Wachusett Aqueduct.[1]	Diverted to the City of Worcester.	Wasted into River below Dam.	Seepage through the North Dike.	STORAGE.[2]		Total yield of Watershed.	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
					Gain.	Loss.				
January,	105,097,000	-	1,645,000	748,000	-	16,116,000	91,374,000	2.91	1.379	47.5
February,	52,654,000	-	1,696,000	750,000	18,743,000	-	73,843,000	2.43	1.007	41.4
March,	38,784,000	-	1,568,000	752,000	117,206,000	-	158,310,000	3.79	2.389	63.0
April,	250,000[3]	-	1,877,000	827,000	161,653,000	-	164,607,000	2.22	2.404	108.5
May,	27,797,000	-	1,816,000	871,000	23,958,000	-	54,442,000	1.59	0.822	51.6
June,	61,537,000	-	2,113,000	877,000	-	23,050,000	41,477,000	2.37	0.606	25.5
July,	78,739,000	-	2,761,000	858,000	-	75,681,000	6,677,000	2.53	0.101	4.0
August,	85,658,000	4,284,000	2,526,000	822,000	-	71,061,000	22,229,000	5.46	0.335	6.1
September,	71,047,000	2,753,000	1,820,000	800,000	-	54,980,000	21,440,000	3.04	0.313	10.3
October,	70,161,000	6,710,000	1,358,000	778,000	5,816,000	-	84,823,000	5.24	1.280	24.4
November,	115,540,000	10,877,000	1,797,000	776,000	-	6,713,000	122,277,000	4.14	1.786	43.1
December,	79,952,000	2,342,000	1,758,000	774,000	41,239,000	-	126,065,000	3.01	1.903	63.2
Total,	-	-	-	-	-	-	-	38.73	14.325	-
Average for year,	65,746,000	2,253,000	1,396,000	803,000	9,913,000	-	80,611,000	-	-	37.0

[1] Including 145,300 gallons per day drawn from aqueduct for the supply of the Westborough Insane Hospital.

[2] Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

[3] Quantity wasted in cleaning aqueduct.

TABLE NO. 10. — *Sudbury System. — Statistics of Flow of Water, Storage and Rainfall in 1911.*

[Watershed from 1875 to 1878 inclusive = 77.764 square miles; in 1879 and 1880 = 78.238 square miles; and from 1881 to 1911 inclusive = 75.2 square miles.]

MONTH.	GALLONS PER DAY.									Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
	Water received from Wachusett Reservoirs.[1]	Water discharged through Sudbury Aqueduct.	Water discharged through Weston Aqueduct.	Water used by Framingham Water Works.	Water diverted from Watershed by Sewers, etc.	Water wasted into River below Lowest Dam.	STORAGE.		Total Yield of Watershed.			
							Gain.	Loss.				
January,	104,952,000	89,235,000	28,571,000	768,000	697,000	21,958,000	2,726,000	-	39,003,000	2.88	0.925	32.1
February,	52,500,000	79,300,000	28,182,000	675,000	1,000,000	9,179,000	-	13,164,000	52,671,000	2.77	1.128	40.7
March,	38,619,000	69,365,000	28,242,000	681,000	913,000	18,284,000	7,197,000	-	86,061,000	3.59	2.042	56.9
April,	-	66,560,000	27,943,000	707,000	1,110,000	18,253,000	-	7,430,000	107,210,000	2.81	2.462	87.4
May,	27,726,000	84,067,000	28,235,000	794,000	620,000	1,503,000	-	63,623,000	23,900,000	1.01	0.567	56.1
June,	61,360,000	78,430,000	27,903,000	737,000	593,000	1,500,000	-	31,800,000	16,003,000	2.53	0.367	14.5
July,	78,535,000	66,603,000	29,323,000	842,000	445,000	1,500,000	-	21,252,000	—1,074,000	3.19	—0.025	—0.8
August,	85,500,000	61,503,000	29,503,000	732,000	590,000	1,500,000	-	6,797,000	1,532,000	4.94	0.036	0.7
September,	70,907,000	56,907,000	29,873,000	677,000	647,000	1,500,000	-	13,013,000	5,683,000	2.75	0.130	4.8
October,	70,003,000	64,329,000	29,987,000	652,000	848,000	2,419,000	-	5,971,000	22,281,000	3.69	0.528	14.3
November,	115,383,000	67,543,000	34,540,000	670,000	1,073,000	10,310,000	45,867,000	-	44,620,000	4.62	1.024	22.2
December,	70,800,000	63,287,000	35,632,000	739,000	1,252,000	20,206,000	26,987,000	-	68,303,000	3.60	1.620	45.0
Total,	-	-	-	-	-	-	-	-	-	38.38	10.804	-
Av. for year,	65,580,000	70,560,000	29,839,000	723,000	815,000	9,020,000	-	6,692,000	38,685,000	-	-	28.2

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[1] Not including 145,300 gallons per day drawn from the Wachusett Aqueduct for the supply of the Westborough Insane Hospital, which were not discharged into Sudbury Reservoir.

TABLE NO. 11. — *Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1911.*

[Watershed of lake = 17.58 square miles.[1]]

MONTH.	GALLONS PER DAY. Water discharged through Cochituate Aqueduct.	Water diverted from Watershed by Sewers, etc.	Water wasted at Outlet of Lake.	STORAGE. Gain.	STORAGE. Loss.	Total Yield of Watershed.	Rainfall (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
January,	403,000	271,000	-	8,100,000	-	8,774,000	2.74	0.89	32.3
February,	10,604,000	561,000	-	2,168,000	-	13,332,000	3.20	1.22	38.2
March,	13,658,000	623,000	-	5,448,000	-	19,729,000	3.31	2.00	60.5
April,	10,907,000	960,000	2,200,000	8,013,000	-	22,080,000	2.73	2.17	79.4
May,	-	413,000	2,271,000	165,000	-	2,848,000	0.65	0.29	44.5
June,	943,000	357,000	1,403,000	-	1,380,000	1,323,000	2.53	0.13	5.1
July,	21,903,000	145,000	-	-	21,458,000	590,000	3.42	0.06	1.8
August,	21,548,000	184,000	-	-	16,203,000	5,529,000	4.82	0.56	11.6
September,	19,063,000	320,000	-	-	13,143,000	6,240,000	2.96	0.61	20.7
October,	11,400,000	352,000	-	-	2,823,000	8,929,000	3.53	0.91	25.7
November,	1,410,000	547,000	-	10,177,000	-	12,133,000	4.28	1.19	27.8
December,	2,345,000	829,000	-	14,519,000	-	17,694,000	3.74	1.79	46.4
Total,	-	-	-	-	-	-	37.91	11.82	-
Average for year,	9,522,000	462,000	489,000	-	573,000	9,900,000	-	-	31.2

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[1] Not including the watersheds of Dudley and Dug ponds.

TABLE NO. 12. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

DATE.	Chestnut Hill Reservoir.	Lake Cochituate.	Farm Pond.	Spot Pond.	Weston Reservoir.	FRAMINGHAM RESERVOIR.			Ashland Reservoir.	Sudbury Reservoir.	Hopkinton Reservoir.	Whitehall Reservoir.	Wachusett Reservoir.
						No. 1.	No. 2.	No. 3.					
	Ordinary High Water =134.00.	High Water =144.36.	High Water =159.25.	High Water =163.00.	High Water =200.00.	Flash Boards 169.27.	Flash Boards 177.12.	Flash Boards 186.50.	Flash Boards 225.23.	Flash Boards 259.97.	Flash Boards 305.00.	Ordinary High Water =337.91.	Ordinary High Water =395.00.
Jan. 1, 1911, .	133.70	141.19	157.42	162.66	200.07	167.74	176.06	183.64	224.40	259.25	304.16	335.70	379.35
Feb. 1, 1911, .	133.76	142.33	157.59	162.66	200.05	167.68	175.99	184.42	224.43	259.12	304 17	336.08	378.72
Mar. 1, 1911, .	133.94	142.60	157.83	162.63	199.96	167.69	176.00	182.69	224.48	258.96	299.80	336.51	379.17
April 1, 1911, .	133.88	143.32	157.92	162.88	200.04	167.70	176.04	182.85	225.39	259.00	299.55	337.30	382.15
May 1, 1911, .	133.94	144.28	157.89	162.76	200.01	167.61	176.51	181.91	224.70	257.91	304.67	337.38	386.33
June 1, 1911, .	133.91	144.30	157.51	162.32	200.02	167.47	176.53	182.52	218.84	254.80	297.30	337.39	387.10
July 1, 1911, .	133.56	144.14	157.20	161.56	199.98	167.26	176.12	183.49	209.75	254.64	286.34	337.32	386.69
Aug. 1, 1911, .	132.31	141.28	156.75	162.00	200.02	166.95	171.02	183.80	192.86	255.99	272.71	337.00	384.86
Sept. 1, 1911, .	132.54	138.86	156.64	163.11	200.08	166.77	173.04	183.95	193.99	255.55	273.40	336.20	383.07
Oct. 1, 1911, .	132.22	136.74	156.46	162.80	200.02	166.68	176.62	183.97	195.15	254.84	274.14	334.64	381.67
Nov. 1, 1911, .	132.37	136.23	156.51	162.86	199.96	167.62	177.12	184.18	197.62	253.79	276.24	334.84	381.53
Dec. 1, 1911, .	134.06	137.94	156.71	162.84	199.88	167.73	177.27	184.05	202.41	256.29	280.93	335.40	381.20
Jan. 1, 1912, .	133.83	140.21	156.95	162.79	199.98	167.70	177.29	184.00	208.51	256.97	286.66	336.13	382.30

TABLE No. 13. — *Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District.*

From Wachusett Reservoir into the Wachusett Aqueduct.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	31	725	-	3,258.0
February,	19	423	40	1,474.3
March,	9	195	-	1,202.3
April,	-	-	-	0.0
May,	6	113	30	861.7
June,	19	393	30	1,846.1
July,	26	573	55	2,440.9
August,	27	474	23	2,655.4
September,	23	468	45	2,131.4
October,	26	311	52	2,175.0
November,	30	664	3	3,466.2
December,	27	411	34	2,478.5
Totals,	243	4,755	12	23,989.8

Total actual time, 198.13 days.
Total quantity drawn, 23,989,800,000 gallons.

From Sudbury Reservoir through the Weston Aqueduct to Weston Reservoir.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	31	744	-	885.7
February,	28	672	-	789.1
March,	31	744	-	875.5
April,	30	720	-	838.3
May,	31	742	30	875.3
June,	30	720	-	837.1
July,	31	744	-	909.0
August,	31	744	-	914.6
September,	30	720	-	896.2
October,	31	744	-	929.6
November,	30	720	-	1,036.2
December,	31	744	-	1,104.6
Totals,	365	8,758	30	10,891.2

Total actual time, 364.94 days.
Total quantity drawn, 10,891,200,000 gallons.

TABLE No. 13 — *Continued.*

From Framingham Reservoir No. 2 through the Sudbury Aqueduct to Chestnut Hill Reservoir.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	1	24	-	20.0
February,	28	672	-	880.9
March,	30	670	30	1,070.4
April,	30	720	-	1,287.6
May,	31	744	-	1,330.8
June,	30	720	-	1,289.0
July,	31	744	-	1,231.9
August,	1	24	-	33.0
September,	26	617	-	256.9
October,	31	744	-	309.7
November,	30	720	-	299.6
December,	31	744	-	309.3
Totals,	301	7,143	30	8,319.1

Total actual time, 297.65 days.
Total quantity drawn, 8,319,100,000 gallons.

From Framingham Reservoir No. 3 through the Sudbury Aqueduct to Chestnut Hill Reservoir.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	31	744	-	2,746.3
February,	28	672	-	1,339.5
March,	31	744	-	1,079.9
April,	30	720	-	709.2
May,	31	744	-	1,275.9
June,	30	720	-	1,063.9
July,	31	744	-	832.8
August,	31	744	-	1,873.6
September,	30	720	-	1,450.3
October,	31	744	-	1,684.5
November,	30	720	-	1,726.7
December,	31	744	-	1,652.6
Totals,	365	8,760	-	17,435.2

Total actual time, 365 days.
Total quantity drawn, 17,435,200,000 gallons.

TABLE No. 13 — *Concluded.*

From Lake Cochituate through the Cochituate Aqueduct to Chestnut Hill Reservoir.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	1	24	-	12.5
February,	28	672	-	296.9
March,	31	744	-	423.4
April,	22	511	-	327.2
May,	-	-	-	0.0
June,	2	48	-	28.3
July,	31	741	-	679.0
August,	31	744	-	668.0
September,	30	720	-	571.9
October,	23	552	-	353.4
November,	4	96	-	42.3
December,	7	152	30	72.7
Totals,	210	5,004	30	3,475.6

Total actual time, 208.52 days.
Total quantity drawn, 3,475,600,000 gallons.

TABLE No. 14. — *Average Daily Quantity of Water flowing through Aqueducts in 1911 by Months.*[1]

MONTH.	Wachusett Aqueduct into Sudbury Reservoir (Gallons).	Weston Aqueduct into Metropolitan District (Gallons).	Sudbury Aqueduct into Chestnut Hill Reservoir (Gallons).	Cochituate Aqueduct into Chestnut Hill Reservoir (Gallons).
January,	104,952,000	28,571,000	89,235,000	403,000
February,	52,500,000	28,182,000	79,300,000	10,604,000
March,	38,619,000	28,242,000	69,365,000	13,658,000
April,	-	27,943,000	66,560,000	10,907,000
May,	27,726,000	28,235,000	84,087,000	-
June,	61,360,000	27,903,000	78,430,000	943,000
July,	78,535,000	29,323,000	66,603,000	21,903,000
August,	85,500,000	29,503,000	61,503,000	21,548,000
September,	70,907,000	29,873,000	56,907,000	19,063,000
October,	70,003,000	29,987,000	64,329,000	11,400,000
November,	115,383,000	34,540,000	67,543,000	1,410,000
December,	79,800,000	35,632,000	63,287,000	2,345,000
Average,	65,580,000	29,839,000	70,560,000	9,522,000

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[1] Not including quantities wasted while cleaning and repairing aqueducts.

TABLE No. 15. — *Statement of Operation of Engines Nos. 1 and 2 at Chestnut Hill Pumping Station No. 1 for the Year 1911.*

[3 per cent. allowed for slip.]

MONTH.	ENGINE No. 1.		ENGINE No. 2.		Total Quantity pumped (Million Gallons).	Coal consumed in Pumping (Pounds).	Coal used in Banking (Pounds).	Ashes and Clinkers from Coal used in Pumping (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal used in Pumping.	AVERAGE LIFT (FEET).		Duty in Foot-pounds per 100 pounds of Coal used in Pumping.	Duty in Foot-pounds per 100 Pounds of Coal used in Pumping, on Basis of Plunger Displacement.
	Total Pumping Time.	Quantity pumped, corrected for Slip (Million Gallons).	Total Pumping Time.	Quantity pumped, corrected for Slip (Million Gallons).							Engine No. 1.	Engine No. 2.		
	Hrs. Min.		Hrs. Min.											
January,	- -	-	329 00	112.64	112.64	201,092	35,883	22,213	11.0	560.14	-	121.37	56,630,000	58,390,000
February,	- -	-	249 00	85.09	85.09	155,135	43,975	18,781	12.1	548.49	-	121.77	55,640,000	57,370,000
March,	- -	-	108 00	36.21	36.21	67,453	56,677	8,147	12.1	536.82	-	120.28	53,790,000	55,460,000
April,	- -	-	90 10	31.52	31.52	57,300	37,200	6,623	11.6	550.09	-	118.48	54,290,000	55,980,000
May,	147 20	52.75	40 10	14.41	67.16	95,015	32,200	11,528	12.1	706.84	120.26	120.52	79,840,000	73,040,000
June,	- -	-	177 30	63.75	63.75	116,280	52,335	13,709	11.8	548.25	-	133.33	60,890,000	62,780,000
July,	- -	-	175 10	63.54	63.54	105,050	18,730	19,774	18.8	604.85	-	135.88	68,460,000	70,590,000
August,	- -	-	127 00	44.67	44.67	73,175	14,935	11,373	15.6	610.45	-	135.93	69,120,000	71,270,000
September,	- -	-	114 00	40.46	40.46	69,225	11,205	10,766	15.6	584.47	-	136.14	66,280,000	68,340,000
October,	25 05	9.25	82 35	28.82	38.07	70,810	11,070	9,920	14.0	537.64	136.85	136.41	61,140,000	63,040,000
November,	126 40	43.87	- -	-	43.87	69,610	20,130	8,712	12.5	630.23	135.26	-	71,010,000	73,220,000
December,	20 30	6.55	115 30	38.01	44.56	89,625	31,140	9,925	11.1	497.18	134.98	134.75	55,820,000	57,560,000
Total,	310 35	112.42	1,608 05	559.12	671.54	1,160,770	365,480	151,471	-	-	-	-	-	-
Average,	- -	-	- -	-	-	-	-	-	12.9	574.08	128.34	128.10	61,280,000	63,190,000

TABLE No. 16. — *Statement of Operation of Engine No. 4 at Chestnut Hill Pumping Station No. 1 for the Year 1911.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed in Pumping (Pounds).	Coal used in Banking (Pounds).	Ashes and Clinkers from Coal used in Pumping (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal used in Pumping.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal used in Pumping, corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal used in Pumping, on Basis of Plunger Displacement.	SUMMARY OF ENGINES Nos. 1, 2 AND 4. Total Quantity pumped, corrected for Slip (Million Gallons).	SUMMARY OF ENGINES Nos. 1, 2 AND 4. Daily Average Quantity pumped (Million Gallons).
	Hrs.	Min.											
January,	742	10	953.29	727,990	-	70,335	10.9	1,309.48	129.65	141,420,000	144,260,000	1,065.93	34.385
February,	672	00	861.54	701,770	3,118	86,099	12.3	1,227.67	130.66	133,620,000	136,310,000	946.63	33.808
March,	741	50	931.74	709,050	4,958	71,808	10.0	1,314.07	130.17	142,490,000	145,350,000	967.95	31.224
April,	644	55	800.00	617,880	8,615	72,430	11.7	1,294.75	129.88	140,080,000	142,900,000	831.52	27.751
May,	717	00	913.55	709,667	5,270	77,035	10.9	1,287.29	129.88	139,270,000	142,070,000	980.71	31.636
June,	348	45	441.40	310,677	51,055	37,930	12.2	1,420.77	119.75	141,720,000	144,570,000	505.15	16.838
July,	-	-	-	-	78,605	-	-	-	-	-	-	63.54	2.050
August,	-	-	-	-	73,435	-	-	-	-	-	-	44.67	1.441
September,	-	-	-	-	74,425	-	-	-	-	-	-	40.46	1.349
October,	-	-	-	-	53,530	-	-	-	-	-	-	38.07	1.228
November,	201	10	241.00	179,200	50,690	21,565	12.0	1,344.87	122.91	137,690,000	140,460,000	284.87	9.496
December,	558	10	662.10	472,760	18,630	57,128	12.1	1,400.50	119.56	139,480,000	142,280,000	706.66	22.795
Total,	4,626	00	5,804.62	4,428,994	422,331	503,330	-	-	-	-	-	6,476.16	-
Average,	-	-	-	-	-	-	11.4	1,310.60	127.77	139,490,000	142,290,000	-	17.743

TABLE No. 17. — *Statement of Operation of Engine No. 12 at Chestnut Hill Pumping Station No. 2 for the Year 1911.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time. Hrs.	Total Pumping Time. Min.	Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed in Pumping (Pounds).	Coal used in Banking (Pounds).	Ashes and Clinkers from Coal used in Pumping (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal used in Pumping.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal used in Pumping, corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal used in Pumping, on Basis of Plunger Displacement.
January,	-	-	-	-	-	-	-	-	-	-	-
February,	-	-	-	-	-	-	-	-	-	-	-
March,	27	11	21.08	25,700	4,920	3,598	14.0	820.23	127.19	86,900,000	88,660,000
April,	94	08	115.76	90,330	21,230	12,900	14.3	1,281.52	132.02	140,930,000	143,790,000
May,	55	40	66.01	57,305	20,900	5,125	8.9	1,151.91	131.36	126,050,000	128,610,000
June,	368	18	485.06	334,090	13,755	44,650	13.4	1,451.88	122.17	147,750,000	150,750,000
July,	742	20	1,038.61	728,035	-	103,630	14.2	1,426.59	124.97	148,510,000	151,520,000
August,	740	20	955.75	639,970	1,805	63,840	10.0	1,493.43	124.84	155,300,000	158,450,000
September,	715	05	902.02	597,285	-	80,850	13.5	1,510.20	124.21	156,260,000	159,430,000
October,	744	00	917.87	604,370	-	94,170	15.6	1,518.72	121.98	154,320,000	157,450,000
November,	506	45	630.48	386,770	3,465	51,980	13.4	1,630.12	118.96	161,530,000	164,810,000
December,	180	45	219.47	162,260	35,795	22,425	13.8	1,352.58	119.12	134,210,000	136,910,000
Total,	4,174	32	5,352.11	3,626,115	101,870	483,168	-	-	-	-	-
Average,	-	-	-	-	-	-	13.3	1,475.99	123.34	151,650,000	154,730,000

TABLE No. 18. — *Statement of Operation of Engines Nos. 5, 6 and 7, at Chestnut Hill Pumping Station No. 2 for the Year 1911.*

[2 per cent. allowed for slip.]

Month.	Engine No. 5.			Engine No. 6.			Engine No. 7.			Total Quantity pumped (Million Gallons).	Daily Average Quantity pumped (Million Gallons).	Total Coal consumed (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal, no Deduction for Heating or Lighting.	Average Lift (Feet).			Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement; no Deduction for Heating or Lighting.
	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).						Engine No. 5.	Engine No. 6.	Engine No. 7.		
	Hrs.	Min.		Hrs.	Min.		Hrs.	Min.											
January,	696	15	756.54	707	05	771.45	173	30	208.21	1,736.20	56.006	667,175	13.2	2,602.32	50.30	50.06	22.94	101,690,000	103,770,000
February,	626	20	667.75	648	25	700.39	209	40	242.06	1,610.20	57.507	645,760	10.7	2,493.50	50.50	50.30	22.10	95,840,000	97,800,000
March,	700	50	770.82	719	40	797.32	52	10	67.01	1,635.15	52.747	653,580	14.0	2,501.84	48.08	44.58	22.96	94,500,000	96,440,000
April,	422	40	460.00	698	35	816.22	142	40	136.40	1,412.62	47.087	517,505	13.7	2,729.67	47.07	45.84	20.08	99,490,000	101,530,000
May,	457	30	486.98	744	00	814.84	269	10	284.31	1,586.13	51.165	592,960	11.5	2,681.15	54.61	55.10	21.98	109,470,000	111,710,000
June,	530	25	571.19	485	30	536.87	317	00	306.16	1,414.22	47.141	529,105	12.8	2,672.85	56.99	56.68	21.73	109,630,000	111,880,000
July,	742	10	788.40	552	50	566.96	250	25	276.91	1,632.27	52.654	636,565	13.5	2,564.18	58.49	58.04	24.50	112,280,000	114,580,000
August,	638	10	649.80	673	10	694.90	194	25	205.95	1,550.65	50.021	558,260	9.3	2,777.65	54.93	54.73	25.13	117,730,000	120,140,000
September,	193	10	195.08	720	00	874.03	277	05	255.98	1,325.09	44.170	449,000	11.5	2,951.20	50.91	47.53	22.79	106,320,000	108,500,000
October,	234	35	272.69	584	35	730.48	374	30	352.16	1,355.33	43.720	464,850	13.0	2,915.63	50.97	48.42	22.63	102,570,000	104,670,000
November,	210	50	215.90	592	55	691.85	285	15	227.06	1,134.81	37.827	440,010	11.9	2,579.06	45.68	44.16	31.53	90,060,000	91,910,000
December,	149	00	152.24	693	45	802.80	237	00	183.00	1,138.04	36.711	442,690	11.8	2,577.90	44.57	42.12	32.38	87,790,000	89,590,000
Total,	5,601	55	5,987.39	7,820	30	8,798.11	2,782	50	2,745.21	17,530.71	-	6,597,460	-	-	-	-	-	-	-
Average,	-	-	-	-	-	-	-	-	-	-	48.029	-	12.3	2,657.19	52.10	49.37	24.10	102,580,000	104,680,000

TABLE No. 19. — *Statement of Operation of Engine No. 8 at Spot Pond Pumping Station for the Year 1911.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed (Pounds).	Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal, no Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs.	Min.								
January,	13	30	5.89	6,570	1,010	15.4	896.50	122.76	91,680,000	93,570,000
February,	-	-	-	-	-	-	-	-	-	-
March,	12	00	5.05	5,227	600	11.5	966.14	124.87	100,490,000	102,560,000
April,	-	-	-	-	-	-	-	-	-	-
May,	15	30	6.79	6,250	560	9.0	1,086.40	120.44	108,990,000	111,240,000
June,	-	-	-	-	-	-	-	-	-	-
July,	-	-	-	-	-	-	-	-	-	-
August,	15	30	6.60	6,990	1,060	15.2	944.21	117.31	92,270,000	94,170,000
September,	-	-	-	-	-	-	-	-	-	-
October,	15	00	6.72	7,310	1,020	14.0	919.29	127.27	97,460,000	99,470,000
November,	-	-	-	-	-	-	-	-	-	-
December,	-	-	-	-	-	-	-	-	-	-
Total,	71	30	31.05	32,347	4,250	-	-	-	-	-
Average,	-	-	-	-	-	13.1	959.90	122.41	97,880,000	99,900,000

TABLE No. 20. — *Statement of Operation of Engine No. 9 at Spot Pond Pumping Station for the Year 1911.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Quantity pumped corrected for Slip (Million Gallons).	Coal consumed (Pounds).	Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal, no Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal on Basis of Plunger Displacement, no Deduction for Heating or Lighting.	SUMMARY OF ENGINES NOS. 8 AND 9.	
	Hrs.	Min.									Total Quantity pumped, corrected for Slip (Million Gallons).	Daily Average Quantity pumped (Million Gallons).
January,	251	20	209.17	183,986	22,069	12.0	1,136.88	130.81	123,880,000	126,390,000	215.06	6.937
February,	238	25	198.38	178,824	23,788	13.3	1,109.36	133.07	122,970,000	125,470,000	198.38	7.085
March,	247	35	205.96	185,574	23,457	12.6	1,109.85	133.31	123,250,000	125,750,000	211.01	6.807
April,	245	30	204.70	182,995	22,492	12.3	1,118.61	133.02	123,950,000	126,470,000	204.70	6.823
May,	293	25	243.78	205,874	25,661	12.5	1,184.12	130.04	128,270,000	130,870,000	250.57	8.083
June,	285	30	236.78	202,645	27,094	13.4	1,168.45	130.20	126,730,000	129,300,000	236.78	7.893
July,	354	10	294.65	242,298	34,717	14.3	1,216.06	131.68	133,390,000	136,100,000	294.65	9.505
August,	297	15	247.30	212,123	26,385	12.4	1,165.83	133.63	129,770,000	132,400,000	253.90	8.190
September,	288	45	237.04	211,280	28,559	13.5	1,121.92	136.93	127,970,000	130,570,000	237.04	7.901
October,	273	10	223.56	201,664	24,193	12.0	1,108.58	137.01	126,520,000	129,090,000	230.28	7.428
November,	261	00	215.04	198,240	26,127	13.2	1,084.75	136.72	123,540,000	126,060,000	215.04	7.168
December,	271	15	222.81	204,565	27,117	13.3	1,089.19	136.15	123,530,000	126,040,000	222.81	7.187
Total,	3,307	20	2,739.17	2,410,068	311,659	-	-	-	-	-	2,770.22	-
Average,	-	-	-	-	-	12.9	1,136.55	133.49	126,380,000	128,950,000	-	7.590

TABLE No. 21. — *Statement of Operation of Engine No. 10 at Arlington Pumping Station for the Year 1911.*

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed (Pounds).	Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal, no Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs.	Min.								
January,	502	15	20.71	69,455	5,849	8.4	298.18	280.99	69,790,000	71,000,000
February,	430	15	17.60	61,520	5,358	8.7	286.09	282.67	67,360,000	68,530,000
March,	500	00	20.84	75,220	7,625	10.1	277.05	282.67	65,240,000	66,370,000
April,	378	30	15.77	56,660	5,656	10.0	278.33	283.17	65,650,000	66,790,000
May,	597	15	27.68	86,390	9,288	10.8	320.41	284.79	76,010,000	77,320,000
June,	570	50	26.46	81,850	9,658	11.8	323.27	284.43	76,590,000	77,920,000
July,	696	00	36.36	104,155	12,419	11.9	349.10	288.55	83,910,000	85,360,000
August,	641	30	30.11	89,670	11,033	12.3	335.79	284.49	79,580,000	80,960,000
September,	636	30	27.36	84,545	9,367	11.1	323.61	282.35	76,110,000	77,430,000
October,	607	00	25.46	80,260	8,816	11.0	317.22	283.02	74,790,000	76,080,000
November,	119	30	5.08	16,600	1,837	11.1	306.02	281.13	71,660,000	72,900,000
December,	309	30	12.31	44,425	4,977	11.2	277.10	282.74	65,260,000	66,390,000
Total,	5,989	05	265.74	850,750	91,883	-	-	-	-	-
Average,	-	-	-	-	-	10.8	312.36	283.95	73,880,000	75,160,000

TABLE No. 22. — *Statement of Operation of Engine No. 11 at Arlington Pumping Station for the Year 1911.*

[4 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed (Pounds).	Ashes and Clinkers (Pounds).	Per Cent. of Ashes and Clinkers.	Gallons pumped per Pound of Coal, no Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting.	SUMMARY OF ENGINES Nos. 10 AND 11.	
											Total Quantity pumped, corrected for Slip (Million Gallons).	Daily Average Quantity pumped (Million Gallons).
	Hrs.	Min.										
January,	-	-	-	-	-	-	-	-	-	-	20.71	.668
February,	49	30	1.48	10,050	885	8.8	147.26	278.50	34,160,000	35,750,000	19.08	.681
March,	-	-	-	-	-	-	-	-	-	-	20.84	.672
April,	162	30	5.62	34,870	3,410	9.8	161.17	284.71	38,220,000	40,000,000	21.39	.713
May,	24	45	.86	6,035	740	12.3	142.50	286.88	34,050,000	35,630,000	28.54	.921
June,	-	-	-	-	-	-	-	-	-	-	26.46	.882
July,	3	00	.10	930	-	-	111.83	288.00	26,830,000	28,080,000	36.46	1.176
August,	-	-	-	-	-	-	-	-	-	-	30.11	.971
September,	16	45	.74	4,245	585	13.8	175.03	277.50	40,460,000	42,340,000	28.10	.937
October,	29	30	1.07	6,520	470	7.2	164.11	285.13	38,980,000	40,790,000	26.53	.856
November,	557	45	19.03	113,580	10,448	9.2	167.55	273.20	38,130,000	39,900,000	24.11	.804
December,	324	00	10.18	62,320	5,870	9.4	163.35	272.40	37,070,000	38,790,000	22.49	.726
Total,	1,167	45	39.08	238,550	22,408	-	-	-	-	-	304.82	-
Average,	-	-	-	-	-	9.4	163.82	275.60	37,610,000	39,360,000	-	.835

TABLE NO. 23. — (*Meter Basis.*) *Average Daily Consumption of Water during the Year 1911, in the Cities and Towns supplied by the Metropolitan Water Works, including Boston, Somerville, Chelsea, Malden, Everett, Quincy, Medford, Melrose, Revere, Watertown, Arlington, Lexington, Milton, Stoneham, Winthrop, Swampscott, Belmont and Nahant. (For Consumption of Water in Whole Metropolitan Water District, see Table No. 26.)*

MONTH.	Average Daily Consumption (Gallons).	Estimated Population.	Consumption per Inhabitant (Gallons).
January,	117,814,500	1,032,690	114
February,	118,747,700	1,034,680	115
March,	112,556,500	1,036,680	109
April,	107,358,100	1,038,670	103
May,	111,980,400	1,044,740	107
June,	109,808,800	1,047,630	104
July,	116,903,200	1,051,800	111
August,	108,391,500	1,051,470	103
September,	106,218,200	1,051,070	101
October,	104,985,400	1,051,080	100
November,	102,482,600	1,052,660	97
December,	103,083,400	1,054,670	98
For the year,	109,994,800	1,046,630	105

In addition to the above quantities, Wakefield was supplied with 83,948,700 gallons, equivalent to a daily average rate of 230,000 gallons, the United States Government Reservation on Peddocks Island with 32,598,000 gallons, equivalent to a daily average rate of 89,300 gallons, and a part of Saugus with 4,782,500 gallons, equivalent to a daily average rate of 13,100 gallons.

TABLE NO. 24. — (*Meter Basis.*) *Average Daily Consumption of Water in Gallons, from the Low-service System in 1911.*

MONTH.	SOUTHERN LOW SERVICE.	NORTHERN LOW SERVICE.	Total Low-service Consumption.
	Boston, excluding East Boston and Charlestown.	Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington.	
January,	49,576,900	26,971,800	76,548,700
February,	49,762,900	28,194,200	77,957,100
March,	47,418,400	26,208,100	73,626,500
April,	44,088,700	24,434,800	68,523,500
May,	45,304,200	25,115,400	70,419,600
June,	43,757,700	24,990,700	68,748,400
July,	45,702,300	26,005,000	71,707,300
August,	43,653,900	24,914,100	68,568,000
September,	43,433,500	24,101,900	67,535,400
October,	43,518,200	23,137,800	66,656,000
November,	44,171,400	21,613,900	65,785,300
December,	44,878,100	21,308,100	66,186,200
For the year,	45,420,600	24,731,900	70,152,500

TABLE No. 25. — (*Meter Basis.*) *Average Daily Consumption of Water, in Gallons, from the High-service and Extra High-service Systems in 1911.*

MONTH.	SOUTHERN HIGH SERVICE.	SOUTHERN EXTRA HIGH SERVICE.	NORTHERN HIGH SERVICE.	NORTHERN EXTRA HIGH SERVICE.
	Quincy, Watertown, and Portions of Boston, Belmont and Milton.	Portions of Boston and Milton.	Revere, Winthrop, Swampscott, Nahant, Stoneham, Melrose, and Portions of Boston, Chelsea, Everett, Malden, Medford and Somerville.	Lexington and Portions of Arlington and Belmont.
January,	33,171,700	625,400	6,800,500	668,200
February,	32,469,000	635,100	7,005,100	681,400
March,	30,870,100	640,100	6,747,500	672,300
April,	30,613,300	646,200	6,862,200	712,900
May,	31,936,200	770,400	7,933,500	920,700
June,	31,480,600	738,500	7,959,300	882,000
July,	33,699,700	880,700	9,439,200	1,176,300
August,	30,255,300	685,000	7,911,600	971,600
September,	29,688,900	660,800	7,396,500	936,600
October,	29,811,300	674,900	6,987,400	855,800
November,	28,483,300	655,000	6,755,400	803,600
December,	28,737,500	661,300	6,772,800	725,600
For the year,	30,931,600[1]	690,100	7,385,500[2]	835,100

In addition to the above [1] the United States Government Reservation on Peddocks Island was supplied with a daily average rate of 89,300 gallons, and [2] part of Saugus with a daily average rate of 13,100 gallons, and Wakefield with a daily average rate of 230,000 gallons.

TABLE NO. 26. — *Average Daily Consumption of Water in Cities and Towns supplied from Metropolitan Works, as measured by Venturi Meters in 1911.*

City or town,	BOSTON.		SOMERVILLE.		MALDEN.		CHELSEA.		EVERETT.		QUINCY.		MEDFORD.	
Population supplied,	688,520.		79,360.		45,780.		33,630.		34,910.		33,760.		24,100.	
MONTH.	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	93,790,600	138	6,226,000	79	1,815,900	40	2,875,100	87	2,789,100	81	2,633,000	79	1,223,400	52
February,	94,230,900	138	6,396,700	81	1,821,300	40	2,999,200	90	2,849,300	83	2,650,600	79	1,210,800	51
March,	89,108,000	130	6,083,600	77	1,793,400	39	2,812,300	85	2,544,900	74	2,604,500	78	1,194,700	50
April,	84,096,900	123	5,923,900	75	1,866,500	41	2,642,400	79	2,459,100	71	2,595,500	77	1,211,600	51
May,	85,982,400	125	6,172,000	78	2,081,200	46	2,726,800	82	2,655,700	77	3,107,300	92	1,362,900	57
June,	84,296,300	123	6,076,600	77	1,970,600	43	2,635,000	79	2,559,300	74	3,163,400	94	1,294,100	54
July,	88,015,600	128	6,186,300	78	2,252,800	49	2,796,500	83	2,842,400	81	3,598,700	107	1,448,200	60
August,	82,764,100	120	5,873,600	74	2,013,100	44	2,736,000	81	2,592,700	74	3,223,500	95	1,222,400	51
September,	82,105,000	119	5,611,500	70	2,008,900	44	2,687,200	79	2,434,700	69	3,124,600	92	1,091,900	45
October,	81,838,500	118	5,510,800	69	2,032,100	44	2,569,700	76	2,372,900	67	2,938,100	86	1,086,000	45
November,	80,108,600	116	5,326,600	67	2,001,200	43	2,481,800	73	2,267,500	64	2,863,200	84	1,094,800	45
December,	80,982,200	117	5,428,400	68	1,963,200	43	2,471,800	73	2,338,200	66	2,577,000	76	1,040,800	43
For the year,	85,571,500	124	5,899,100	74	1,971,300	43	2,701,400	80	2,557,800	73	2,925,400	87	1,207,100	50

TABLE No. 26. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Continued.

City or town,	MELROSE.		REVERE.		WATERTOWN.		ARLINGTON.		MILTON.		WINTHROP.	
Population supplied,	16,670.		19,240.		13,330.		11,700.		8,140.		10,670.	
	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
MONTH.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	935,100	59	1,386,500	73	952,200	72	827,000	72	264,000	33	512,100	49
February,	963,300	60	1,430,300	76	827,300	63	827,600	72	287,800	36	519,300	49
March,	939,000	59	1,281,400	67	851,200	64	818,700	71	305,100	38	486,500	46
April,	958,400	60	1,230,900	65	870,000	66	856,800	74	345,000	43	523,700	50
May,	1,087,500	68	1,468,100	77	970,500	73	1,192,000	102	405,800	50	650,600	61
June,	1,036,100	65	1,541,600	80	906,800	68	1,087,200	93	335,700	41	690,900	65
July,	1,141,900	71	1,772,400	92	1,092,600	82	1,484,300	127	356,800	44	911,500	85
August,	989,300	61	1,618,200	84	895,000	67	1,106,100	94	290,300	36	777,900	73
September,	1,041,700	65	1,496,400	77	830,000	62	999,100	85	297,600	36	608,500	57
October,	1,058,100	66	1,366,300	70	844,600	63	924,300	78	320,000	39	513,400	48
November,	997,400	62	1,313,500	67	819,800	61	833,500	70	314,100	38	484,300	45
December,	996,500	62	1,361,100	70	800,700	59	821,700	69	287,500	35	484,200	45
For the year,	1,012,500	63	1,439,400	75	889,200	67	983,200	84	317,700	39	597,800	56

TABLE No. 26. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Concluded.

City or town,	STONEHAM.		BELMONT.		LEXINGTON.		NAHANT.		SWAMPSCOTT.		METROPOLITAN DISTRICT.	
Population supplied,	7,360.		5,840.		4,590.[1]		2,340.[2]		7,290.[2]		1,046,630.	
	GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.		GALLONS.	
MONTH.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	594,700	82	295,400	52	283,500	63	60,400	49	350,500	55	117,814,500	114
February,	747,400	103	310,400	54	291,400	64	60,700	49	323,400	51	118,747,700	115
March,	727,200	100	333,300	58	292,400	64	60,400	49	319,900	50	112,556,500	109
April,	689,700	94	351,200	61	305,700	67	72,800	58	358,000	56	107,358,100	103
May,	520,100	71	517,600	89	373,400	82	190,400	61	516,100	60	111,980,400	107
June,	565,700	77	500,700	86	366,800	80	255,500	67	526,500	60	109,808,800	104
July,	622,300	85	745,700	128	525,600	115	436,800	84	672,800	70	116,903,200	111
August,	518,000	70	499,800	85	428,500	93	283,100	71	559,900	66	108,391,500	103
September,	507,200	69	376,400	64	375,000	81	181,800	65	440,700	60	106,218,200	101
October,	464,900	63	352,200	60	344,500	75	102,900	61	346,100	54	104,965,400	100
November,	460,100	62	356,000	60	355,200	77	62,000	48	343,000	53	102,482,600	97
December,	477,100	64	334,800	56	286,900	62	46,800	36	364,500	57	103,063,400	98
For the year,	573,300	78	415,500	71	352,900	77	152,000	65	427,700	59	109,994,800	105

[1] Allowance made for district not supplied.

[2] Allowance for summer population.

TABLE No. 27. — (*Pump Basis.*) *Consumption of Water in the Metropolitan Water District, as constituted in the Year 1911, and a Small Section of the Town of Saugus, from 1893 to 1911.*

[Gallons per day.]

MONTH.	1893.	1894.	1895.	1896.	1897.
January,	75,209,000	67,506,000	68,925,000	82,946,000	85,366,000
February,	71,900,000	68,944,000	80,375,000	87,021,000	83,967,000
March,	67,638,000	62,710,000	69,543,000	86,111,000	82,751,000
April,	62,309,000	57,715,000	62,909,000	77,529,000	79,914,000
May,	61,025,000	60,676,000	65,194,000	73,402,000	76,772,000
June,	63,374,000	68,329,000	69,905,000	77,639,000	77,952,000
July,	69,343,000	73,642,000	69,667,000	80,000,000	85,525,000
August,	66,983,000	67,995,000	72,233,000	78,537,000	84,103,000
September,	64,654,000	67,137,000	73,724,000	74,160,000	84,296,000
October,	63,770,000	62,735,000	67,028,000	71,762,000	79,551,000
November,	61,204,000	62,231,000	64,881,000	71,933,000	72,762,000
December,	66,700,000	65,108,000	70,443,000	79,449,000	76,594,000
Average,	66,165,000	65,382,000	69,499,000	78,360,000	80,793,000
Population,	723,153	743,354	763,557	786,385	809,213
Per capita,	91.5	88.0	91.0	99.7	99.8

MONTH.	1898.	1899.	1900.	1901.	1902.
January,	83,880,000	96,442,000	100,055,000	111,275,000	118,435,000
February,	87,475,000	103,454,000	98,945,000	117,497,000	117,268,000
March,	85,468,000	90,200,000	97,753,000	105,509,000	108,461,000
April,	76,574,000	86,491,000	89,497,000	93,317,000	103,153,000
May,	76,677,000	89,448,000	87,780,000	95,567,000	106,692,000
June,	83,463,000	97,691,000	98,581,000	103,420,000	110,002,000
July,	88,228,000	96,821,000	107,786,000	106,905,000	108,340,000
August,	87,558,000	92,072,000	102,717,000	102,815,000	107,045,000
September,	88,296,000	91,478,000	103,612,000	102,103,000	107,752,000
October,	81,770,000	89,580,000	98,358,000	103,389,000	106,560,000
November,	78,177,000	86,719,000	93,648,000	101,324,000	105,175,000
December,	86,355,000	85,840,000	97,844,000	113,268,000	125,434,000
Average,	83,651,000	92,111,000	98,059,000	104,645,000	110,845,000
Population,	832,042	854,870	877,698	892,740	907,780
Per capita,	100.5	107.8	111.7	117.2	121.6

TABLE NO. 27. — (*Pump Basis.*) *Consumption of Water, etc.* — Concluded.

[Gallons per day.]

MONTH.	1903.	1904.	1905.	1906.	1907.
January,	125,176,000	137,771,000	130,878,000	126,093,000	137,730,000
February,	122,728,000	143,222,000	140,595,000	130,766,000	150,822,000
March,	111,977,000	123,334,000	120,879,000	123,570,000	134,202,000
April,	107,179,000	108,688,000	111,898,000	118,428,000	121,556,000
May,	111,589,000	111,715,000	115,804,000	122,404,000	123,502,000
June,	105,590,000	111,209,000	117,441,000	121,882,000	125,623,000
July,	107,562,000	113,584,000	124,769,000	118,726,000	128,779,000
August,	103,570,000	112,836,000	121,158,000	120,591,000	131,098,000
September,	106,772,000	114,188,000	120,103,000	121,685,000	124,751,000
October,	103,602,000	108,290,000	118,301,000	116,561,000	124,051,000
November,	103,477,000	108,054,000	116,693,000	113,746,000	119,627,000
December,	114,721,000	125,119,000	122,696,000	130,995,000	122,407,000
Average,	110,277,000	118,114,000	121,671,000	122,085,000	128,561,000
Population,	922,820	937,860	955,920	981,690	1,007,520
Per capita,	119.5	125.9	127.3	124.4	127.6

MONTH.	1908.	1909.	1910.	1911.
January,	132,376,000	133,275,000	127,568,000	123,281,000
February,	146,199,000	130,763,000	131,093,000	124,359,000
March,	128,884,000	126,842,000	117,078,000	116,669,000
April,	128,926,000	125,335,000	112,775,000	111,656,000
May,	131,040,000	123,305,000	112,073,000	118,095,000
June,	139,843,000	125,179,000	114,082,000	114,145,000
July,	138,232,000	126,765,000	122,743,000	123,052,000
August,	128,073,000	121,781,000	118,373,000	111,091,000
September,	129,972,000	118,043,000	112,434,000	108,726,000
October,	124,189,000	115,939,000	112,332,000	106,873,000
November,	117,119,000	111,664,000	107,528,000	105,373,000
December,	124,468,000	115,733,000	121,994,000	104,592,000
Average,	130,712,000	122,851,000	117,458,000	113,951,000
Population,	1,025,890	1,051,420	1,076,930	1,102,210
Per capita,	127.4	116.8	109.1	103.4

This table includes the water consumed in the cities and towns enumerated in Table No. 23, together with the water consumed in Newton and Hyde Park, which are included in the Metropolitan Water District, but have not been supplied from the Metropolitan Works. The populations for the years 1901 to 1909 were revised after the census of 1905 and of 1910 became available, and consequently the figures in the reports after 1904 and 1909 differ from those published in a corresponding table in the preceding annual reports.

TABLE NO. 28. — *Chemical Examinations of Water from the Wachusett Reservoir, Clinton.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.		Color.	Odor.		Residue on Evaporation.		Ammonia.	Albuminoid.			Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1911.																
90125	Jan. 3	None.	V. slight.	9	V. faintly vegetable.	Faintly vegetable.	3.95	1.60	.0018	.0094	.0084	.0010	.30	.0020	.0000	.22	0.8
90415	Jan. 17	None.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	2.15	1.05	.0022	.0108	.0088	.0020	.27	.0000	.0000	.15	0.8
90649	Jan. 31	None.	None.	8	V. faintly vegetable.	Faintly vegetable.	2.80	1.35	.0016	.0088	.0070	.0018	.25	.0010	.0000	.20	0.8
90923	Feb. 14	None.	V. slight.	10	None.	V. faintly vegetable.	–	–	.0020	.0086	.0074	.0012	.26	.0010	.0000	.23	0.8
91238	Mar. 7	V. slight.	V. slight.	8	V. faintly vegetable.	Faintly vegetable.	2.75	1.30	.0024	.0100	.0080	.0020	.26	.0020	.0000	.22	0.8
91514	Mar. 21	None.	V. slight.	10	Faintly unpleasant.	Distinctly unpleasant and fishy.	2.60	1.15	.0020	.0106	.0082	.0024	.27	.0020	.0000	.25	0.8
91769	Apr. 4	V. slight.	V. slight.	2	Faintly unpleasant.	Distinctly unpleasant and fishy.	3.60	1.70	.0016	.0132	.0126	.0006	.25	.0010	.0000	.21	0.8
92054	Apr. 18	V. slight.	Slight.	2	Faintly unpleasant.	Distinctly unpleasant.	2.55	1.00	.0014	.0092	.0084	.0008	.27	.0010	.0000	.24	0.8
92298	May 2	V. slight.	Slight.	10	V. faintly vegetable.	Faintly vegetable.	3.00	1.20	.0008	0134	.0096	.0038	.26	.0010	.0000	.24	0.8
92527	May 16	V. slight.	Slight.	12	V. faintly vegetable.	V. faintly vegetable.	2.30	1.00	.0018	.0114	.0096	.0018	.27	.0010	.0000	.25	0.8
92891	June 6	V. slight.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	3.85	1.55	.0020	.0114	.0102	.0012	.26	.0010	.0000	.26	1.0
93199	June 20	V. slight.	Slight and organisms.	11	Faintly vegetable and sweetish.	Distinctly vegetable and sweetish.	3.40	1.25	.0008	.0142	.0106	.0036	.28	.0000	.0000	.27	1.1
93540	July 4	V. slight.	V. slight.	10	V. faintly vegetable.	V. faintly vegetable.	2.60	0.85	.0022	.0122	.0104	.0018	.23	.0000	.0000	.31	1.0
93867	July 18	V. slight.	V. slight.	11	None.	V. faintly vegetable.	4.20	2.35	.0008	.0094	.0062	.0032	.25	.0000	.0000	.24	1.1
94201	Aug. 1	Slight.	Slight.	13	V. faintly vegetable.	Faintly vegetable.	2.95	1.45	.0008	.0108	.0090	.0018	.27	.0000	.0000	.25	1.1
94525	Aug. 15	V. slight.	V. slight.	10	V. faintly vegetable.	V. faintly vegetable.	2.80	1.05	.0012	.0114	.0096	.0018	.30	.0000	.0000	.25	0.8
94926	Sept. 5	V. slight.	V. slight.	6	V. faintly vegetable.	Faintly vegetable.	2.85	1.05	.0010	.0134	.0128	.0006	.28	.0000	.0000	.37	1.0
95238	Sept. 19	None.	V. slight.	10	V. faintly vegetable.	V. faintly vegetable.	3.15	1.20	.0008	.0110	0104	.0006	.27	.0000	.0000	.25	0.8
95573	Oct. 3	V. slight.	V. slight.	9	Faintly vegetable.	Faintly vegetable.	2.90	1.00	.0014	.0124	.0118	.0006	.26	.0000	.0000	.22	0.8
95868	Oct. 17	V. slight.	V. slight.	5	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.15	1.05	.0014	.0110	.0102	.0008	.28	.0010	.0000	.25	0.8
96176	Oct. 31	V. slight.	V. slight.	10	Faintly vegetable.	Distinctly vegetable.	2.80	1.00	.0010	.0106	.0084	.0022	.27	.0010	.0000	.16	1.3
96584	Nov. 21	None.	V. slight.	10	Faintly vegetable.	Faintly vegetable.	2.65	0.80	.0014	.0108	.0088	.0020	.29	.0010	.0000	.22	1.3
96885	Dec. 5	V. slight.	V. slight.	9	V. faintly vegetable.	Faintly vegetable.	3.65	1.50	.0024	.0134	.0128	.0006	.31	.0010	.0000	.20	1.3
97190	Dec. 19	None.	V. slight.	8	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	2.80	0.85	.0018	.0100	.0098	.0002	.30	.0010	.0000	.16	1.3
Av.	....	....	....	9	....	....	3.02	1.23	.0015	.0111	.0096	.0016	.27	.0008	.0000	.23	0.9

TABLE NO. 29. — *Chemical Examinations of Water from the Sudbury Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
				COLOR.						ALBUMINOID.							
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
90103	1911. Jan. 2	None.	V. slight.	8	None.	V. faintly vegetable.	3.00	1.50	.0018	.0108	.0084	.0024	.26	.0010	.0000	.22	0.8
90619	Jan. 30	Slight.	Slight.	8	V. faintly vegetable.	Faintly vegetable.	3.10	1.20	.0022	.0112	.0100	.0012	.29	.0030	.0000	.28	0.8
91202	Mar. 6	V. slight.	V. slight.	10	Faintly vegetable.	Faintly vegetable.	3.20	1.35	.0014	.0106	–	–	.31	.0040	.0000	.24	1.3
91734	Apr. 3	Slight.	Slight.	10	Faintly unpleasant.	Distinctly unpleasant and fishy.	3.10	1.20	.0024	.0160	.0112	.0048	.29	.0020	.0000	.24	1.3
92319	May 3	V. slight.	Slight.	9	V. faintly vegetable.	Faintly vegetable.	4.20	1.05	.0020	.0188	.0128	.0060	.34	.0030	.0001	.25	1.3
92850	June 5	V. slight.	V. slight.	15	Faintly vegetable.	Faintly vegetable.	4.05	1.05	.0030	.0128	.0126	.0002	.35	.0040	.0000	.29	1.8
93506	July 3	V. slight.	Slight.	11	Faintly unpleasant.	Distinctly unpleasant and organisms.	4.20	1.40	.0034	.0146	.0124	.0022	.34	.0000	.0000	.25	1.6
94150	July 31	Slight.	Slight.	12	V. faintly vegetable.	V. faintly vegetable.	3.50	0.85	.0022	.0138	.0106	.0032	.32	.0000	.0000	.24	1.1
94913	Sept. 5	V. slight.	V. slight.	10	Faintly vegetable.	Distinctly vegetable.	3.50	1.35	.0012	.0136	.0126	.0010	.27	.0000	.0001	.30	1.1
95526	Oct. 2	V. slight.	V. slight.	10	Faintly vegetable.	Faintly vegetable.	3.15	1.00	.0016	.0162	.0138	.0024	.30	.0000	.0000	.18	1.1
96227	Nov. 6	V. slight.	V. slight.	8	Faintly vegetable.	Faintly vegetable.	3.30	1.25	.0020	.0160	.0142	.0018	.29	.0010	.0000	.08	1.3
96835	Dec. 4	V. slight.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	2.95	1.20	.0024	.0126	.0106	.0020	.32	.0020	.0000	.18	1.3
Av.	....	....	....	10	....	....	3.44	1.20	.0021	.0139	.0117	.0025	.31	.0017	.0000	.23	1.2

TABLE NO. 30. — *Chemical Examinations of Water from Spot Pond, Stoneham.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
				COLOR.						ALBUMINOID.							
		Turbidity.	Sediment.	Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1911.																
90115	Jan. 3	V. slight.	V. slight.	6	V. faintly vegetable.	Faintly vegetable.	3.15	1.55	.0012	.0144	.0108	.0036	.35	.0010	.0000	.23	1.3
90606	Jan. 30	Slight.	Slight.	8	V. faintly vegetable and sweetish.	Faintly vegetable and sweetish.	3.65	1.10	.0022	.0128	.0114	.0014	.36	.0010	.0000	.24	0.8
91187	Mar. 6	V. slight.	Slight.	12	Faintly unpleasant.	Faintly unpleasant.	3.40	1.25	.0030	.0148	.0124	.0024	.35	.0020	.0000	.25	1.3
91756	Apr. 4	V. slight.	Slight.	11	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	3.35	1.15	.0018	.0154	.0112	.0042	.36	.0010	.0000	.26	1.3
92280	May 2	Slight.	Slight.	10	V. faintly unpleasant.	Faintly unpleasant.	3.55	1.30	.0008	.0144	.0122	.0022	.36	.0020	.0000	.38	1.3
92871	June 6	V. slight.	Slight.	17	None.	V. faintly unpleasant.	3.55	1.55	.0018	.0094	.0084	.0010	.36	.0010	.0001	.32	1.4
93489	July 3	None.	V. slight.	18	Faintly vegetable.	Faintly vegetable and unpleasant.	3.50	0.90	.0006	.0136	.0118	.0018	.35	.0000	.0000	.31	1.3
94243	Aug. 2	Slight.	Slight.	16	V. faintly vegetable.	V. faintly vegetable.	3.90	1.00	.0022	.0116	.0108	.0008	.37	.0000	.0000	.35	1.6
95193	Sept. 15	V. slight.	V. slight.	11	V. faintly vegetable.	Faintly vegetable.	3.70	1.20	.0030	.0146	.0132	.0014	.40	.0000	.0000	.25	1.9
95578	Oct. 4	V. slight.	Slight.	16	Faintly vegetable and sweetish.	Distinctly vegetable and sweetish.	3.50	1.00	.0024	.0218	.0136	.0082	.40	.0010	.0000	.22	1.6
96148	Oct. 30	V. slight.	V. slight.	10	Faintly unpleasant.	Distinctly unpleasant and fishy.	3.60	1.20	.0016	.0158	.0138	.0020	.39	.0010	.0000	.32	1.3
96862	Dec. 5	V. slight.	V. slight.	10	Faintly vegetable and sweetish.	Distinctly vegetable and sweetish.	3.75	1.05	.0012	.0144	.0130	.0014	.40	.0010	.0000	.22	1.7
Av.	....	....	....	12	....	....	3.55	1.19	.0018	.0144	.0119	.0025	.37	.0009	.0000	.28	1.4

TABLE NO. 31. — *Chemical Examinations of Water from Lake Cochituate.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
				Platinum Standard.						Total.	Dissolved.	Suspended.					
	1911.																
90167	Jan. 2	V. slight.	V. slight.	13	Distinctly unpleasant, decaying organisms.	Decidedly unpleasant, decaying organisms.	5.80	2.00	.0016	.0196	.0152	.0044	.59	.0000	.0002	.36	2.0
90748	Feb. 6	V. slight.	V. slight.	15	V. faintly vegetable.	Faintly vegetable.	5.75	1.85	.0024	.0212	.0152	.0060	.65	.0000	.0000	.34	2.2
91212	Mar. 6	Slight.	Slight.	12	Faintly unpleasant, decaying organisms.	Distinctly unpleasant, decaying organisms.	5.70	2.20	.0032	.0186	.0148	.0038	.63	.0010	.0000	.31	2.2
91785	Apr. 3	V. slight.	Slight.	14	Distinctly unpleasant.	Distinctly unpleasant.	5.00	2.25	.0020	.0178	.0150	.0028	.59	.0030	.0000	.46	2.2
92266	May 1	Slight.	Slight.	14	Faintly unpleasant.	Distinctly unpleasant.	5.55	1.60	.0012	.0232	.0164	.0068	.65	.0000	.0001	.30	2.2
92843	June 5	V. slight.	Slight.	12	Faintly unpleasant.	Distinctly unpleasant.	5.85	2.15	.0016	.0206	.0164	.0042	.66	.0010	.0001	.33	2.5
93500	July 3	V. slight.	Slight.	15	Faintly unpleasant.	Distinctly unpleasant.	6.30	2.30	.0036	.0178	.0160	.0018	.68	.0000	.0000	.42	2.6
94166	July 31	V. slight.	Slight.	16	V. faintly vegetable.	Faintly vegetable.	6.30	2.05	.0018	.0184	.0158	.0026	.66	.0000	.0000	.36	2.7
94916	Sept. 5	V. slight.	V. slight.	11	V. faintly unpleasant.	Faintly unpleasant.	6.50	1.95	.0014	.0204	.0178	.0026	.72	.0000	.0002	.29	2.7
95558	Oct. 2	V. slight.	Slight.	12	Faintly vegetable and sweetish.	Distinctly vegetable and sweetish.	6.15	1.70	.0008	.0200	.0172	.0028	.72	.0000	.0000	.38	2.7
96240	Nov. 6	V. slight.	Considerable.	10	Faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	6.40	1.80	.0002	.0216	.0150	.0066	.70	.0000	.0000	.29	2.5
96830	Dec. 4	Slight.	Considerable.	10	Distinctly vegetable.	Distinctly vegetable.	6.45	1.75	.0008	.0248	.0148	.0100	.70	.0000	.0000	.30	2.7
Av.	....	....	....	13	....	....	5.98	1.97	.0017	.0203	.0158	.0045	.67	.0004	.0001	.35	2.4

TABLE NO. 32. — *Chemical Examinations of Water from a Tap at the State House, Boston.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Hardness.
		Turbidity.	Sediment.	Color. Platinum Standard.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1911.																
90111	Jan. 3	None.	V. slight.	10	V. faintly vegetable.	Faintly vegetable.	3.50	1.55	.0024	.0104	.0094	.0010	.28	.0030	.0000	.18	0.8
90599	Jan. 30	V. slight.	Slight.	9	Distinctly geranium, Asterionella.	Distinctly geranium, Asterionella.	3.70	1.70	.0014	.0128	.0082	.0046	.29	.0040	.0000	.21	0.8
91184	Mar. 6	V. slight.	V. slight.	25	Distinctly geranium.	Distinctly vegetable and faintly unpleasant.	3.80	1.60	.0016	.0132	.0110	.0022	.42	.0050	.0000	.36	1.7
91718	Apr. 3	Slight.	Slight.	32	Faintly vegetable.	Distinctly vegetable.	4.80	1.90	.0020	.0172	.0146	.0026	.41	.0030	.0000	.36	1.6
92262	May 1	Slight.	Slight.	45	Distinctly vegetable.	Decidedly vegetable.	4.40	1.60	.0022	.0214	.0162	.0052	.39	.0020	.0001	.55	1.3
92854	June 6	V. slight.	Slight.	35	Faintly vegetable.	Faintly vegetable.	3.80	1.35	.0020	.0186	.0150	.0036	.36	.0040	.0001	.51	1.1
93480	July 3	V. slight.	V. slight.	47	Faintly vegetable.	Distinctly vegetable.	4.25	2.25	.0008	.0200	.0162	.0038	.39	.0030	.0001	.62	1.4
94124	July 31	Slight.	Slight.	32	Faintly vegetable.	Faintly vegetable.	4.55	1.45	.0014	.0152	.0124	.0028	.41	.0000	.0000	.40	1.8
94899	Sept. 5	V. slight.	V. slight.	9	Faintly vegetable.	Distinctly vegetable.	3.90	1.50	.0002	.0120	.0102	.0018	.38	.0020	.0000	.15	1.4
95514	Oct. 2	V. slight.	V. slight.	13	Faintly vegetable.	Distinctly vegetable.	4.00	1.15	.0014	.0156	.0144	.0012	.36	.0020	.0000	.29	1.4
96225	Nov. 6	V. slight.	V. slight.	17	None.	None.	4.30	1.70	.0010	.0140	.0130	.0010	.35	.0020	.0000	.24	1.6
96811	Dec. 4	V. slight.	Slight.	20	V. faintly vegetable.	Faintly vegetable.	5.15	2.15	.0014	.0170	.0126	.0044	.47	.0050	.0001	.28	2.0
Av.	....	....	....	25	....	....	4.18	1.66	.0015	.0156	.0128	.0029	.38	.0029	.0000	.33	1.4

TABLE NO. 33. — *Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1911.*

[Parts per 100,000.]

LOCALITY.	Samples collected.	COLOR.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
						ALBUMINOID.							
		Platinum Standard.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
Quinepoxet River, Holden,	Semi-monthly,	43	4.22	1.69	.0023	.0171	.0152	.0019	.43	.0035	.0001	.57	1.0
Stillwater River, Sterling,	Semi-monthly,	35	3.64	1.45	.0022	.0143	.0163	.0021	.25	.0017	.0001	.44	1.0
Wachusett Reservoir, West Boylston,	Semi-monthly,	27	3.47	1.36	.0020	.0146	.0119	.0027	.30	.0022	.0001	.41	1.0
Wachusett Reservoir, Clinton, surface,	Semi-monthly,	9	3.02	1.23	.0015	.0111	.0096	.0016	.27	.0008	.0000	.23	0.9
Wachusett Reservoir, Clinton, bottom,	Semi-monthly,	10	2.96	1.17	.0021	.0097	.0085	.0011	.27	.0016	.0000	.23	0.9
Marlborough (Walker's Brook),[1]	Monthly,	61	22.64	6.31	.5776	.0544	.0391	.0154	3.78	.1089	.0111	.84	7.6
Marlborough Brook filter-beds, effluent,[2]	Monthly,	10	20.86	–	.0335	.0130	–	–	2.65	.3929	.0068	–	7.0
Wachusett Aqueduct, Southborough,[3]	Monthly,	11	3.25	1.30	.0025	.0117	.0101	.0019	.28	.0020	.0000	.26	1.1
Sudbury Reservoir, surface,	Monthly,	10	3.44	1.20	.0021	.0139	.0117	.0025	.31	.0017	.0000	.23	1.2
Sudbury Reservoir, bottom,	Monthly,	10	3.47	1.28	.0028	.0129	.0107	.0021	.31	.0017	.0000	.24	1.2
Framingham Reservoir No. 3, inlet,	Monthly,	11	3.44	1.23	.0033	.0122	.0102	.0020	.30	.0043	.0001	.25	1.4
Framingham Reservoir No. 3, near dam,	Monthly,	11	3.41	1.36	.0033	.0145	.0113	.0033	.29	.0014	.0000	.28	1.3
Hopkinton Reservoir, inlet,	Monthly,	140	7.32	3.73	.0044	.0360	.0332	.0043	.54	.0019	.0001	1.48	1.9
Hopkinton Reservoir, surface,	Monthly,	43	4.27	1.63	.0026	.0184	.0166	.0018	.41	.0015	.0000	.57	1.3
Hopkinton Reservoir, bottom,	Monthly,	47	4.52	2.01	.0035	.0182	.0167	.0015	.43	.0022	.0000	.63	1.3
Ashland Reservoir, inlet,	Monthly,	105	5.63	2.69	.0038	.0325	.0254	.0070	.41	.0043	.0001	1.21	1.6
Ashland Reservoir, surface,	Monthly,	48	4.25	1.77	.0025	.0225	.0190	.0035	.37	.0017	.0000	.64	1.3
Ashland Reservoir, bottom,	Monthly,	51	4.30	1.86	.0041	.0188	.0192	.0035	.37	.0025	.0000	.66	1.5
Framingham Reservoir No. 2, inlet,[1]	Monthly,	90	6.09	2.72	.0050	.0304	.0265	.0040	.46	.0046	.0001	1.07	1.6
Framingham Reservoir No. 2, near dam,	Monthly,	66	5.16	2.34	.0043	.0250	.0225	.0025	.43	.0032	.0001	.82	1.3
Lake Cochituate, surface,	Monthly,	13	5.98	1.97	.0017	.0203	.0158	.0045	.67	.0004	.0001	.35	2.4
Lake Cochituate, bottom,[1]	Monthly,	51	6.45	2.37	.0275	.0234	.0167	.0067	.65	.0005	.0001	.41	2.5
Weston Reservoir,[4]	Monthly,	10	3.28	1.13	.0022	.0135	.0112	.0023	.30	.0011	.0000	.25	1.4
Terminal chamber, Sudbury Aqueduct,	Monthly,	27	3.87	1.53	.0026	.0162	.0134	.0028	.33	.0017	.0000	.40	1.3
Spot Pond,	Monthly,	12	3.55	1.19	.0018	.0144	.0119	.0025	.37	.0009	.0000	.28	1.4
Tap in Revere,	Monthly,	18	3.42	1.28	.0018	.0136	.0114	.0022	.33	.0007	.0000	.23	1.3
Tap at State House,	Monthly,	25	4.18	1.66	.0015	.0156	.0128	.0029	.38	.0029	.0000	.33	1.4
Tap in Quincy,	Monthly,	21	4.03	1.63	.0014	.0135	.0122	.0012	.38	.0033	.0001	.32	1.6

[1] Average of 11 samples. [2] Average of 7 samples. [3] Average of 10 samples. [4] Average of 9 samples.

TABLE No. 34. — *Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1911.*

[Parts per 100,000.]

YEAR.	COLOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Hardness.
						ALBUMINOID.							
	Nessler Standard.	Platinum Standard.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1892, . .	.37	37	4.70	1.67	.0007	.0168	.0138	.0030	.41	.0210	.0001	–	1.9
1893, . .	.61	53	4.54	1.84	.0010	.0174	.0147	.0027	.38	.0143	.0001	.60	1.8
1894, . .	.69	58	4.64	1.83	.0006	.0169	.0150	.0019	.41	.0106	.0001	.63	1.7
1895, . .	.72	59	4.90	2.02	.0006	.0197	.0175	.0022	.40	.0171	.0001	.69	0.7
1896, . .	.49	45	4.29	1.67	.0005	.0165	.0142	.0023	.37	.0155	.0001	.56	1.4
1897, . .	.65	55	4.82	1.84	.0009	.0193	.0177	.0016	.40	.0137	.0001	.64	1.6
1898, . .	.41	40	4.19	1.60	.0008	.0152	.0136	.0016	.29	.0097	.0001	.44	1.4
1899, . .	.23	28	3.70	1.30	.0006	.0136	.0122	.0014	.24	.0137	.0001	.35	1.1
1900, . .	.24	29	3.80	1.20	.0012	.0157	.0139	.0018	.25	.0076	.0001	.38	1.3
1901, . .	.24	29	4.43	1.64	.0013	.0158	.0142	.0016	.30	.0173	.0001	.42	1.7
1902, . .	.26	30	3.93	1.56	.0016	.0139	.0119	.0020	.29	.0092	.0000	.40	1.3
1903, . .	.25	29	3.98	1.50	.0013	.0125	.0110	.0015	.30	.0142	.0001	.39	1.5
1904, . .	–	23	3.93	1.59	.0023	.0139	.0121	.0018	.34	.0110	.0001	.37	1.5
1905, . .	–	24	3.86	1.59	.0020	.0145	.0124	.0021	.35	.0083	.0001	.35	1.4
1906, . .	–	24	3.86	1.39	.0018	.0159	.0134	.0025	.34	.0054	.0001	.36	1.3
1907, . .	–	22	3.83	1.40	.0013	.0129	.0109	.0020	.33	.0068	.0001	.32	1.3
1908, . .	–	19	3.50	1.35	.0011	.0115	.0092	.0024	.33	.0092	.0001	.26	1.2
1909, . .	–	18	3.46	1.43	.0011	.0128	.0103	.0025	.28	.0034	.0000	.25	1.3
1910, . .	–	14	3.05	1.24	.0013	.0118	.0102	.0016	.28	.0030	.0000	.22	1.1
1911, . .	–	25	4.18	1.66	.0015	.0156	.0128	.0029	.38	.0029	.0000	.33	1.4

Note relating to Chemical Examinations of Water, Tables Nos. 28–34.

The chemical examinations contained in the tables were made by the State Board of Health. Previous to the year 1904 colors were determined by the Nessler standard, but the corresponding values by the platinum standard are also given, for the purpose of comparison with colors determined in the laboratory of the Metropolitan Water and Sewerage Board, as given in subsequent tables. The odor recorded is taken in such a way that it is a much stronger odor than would be noticed in samples drawn directly from a tap or collected directly from a reservoir. The important samples are collected and examined semimonthly or monthly.

TABLE No. 35. — *Microscopic Organisms in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1911, inclusive.*

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WACHUSETT RESERVOIR.		SUDBURY RESERVOIR.		LAKE COCHITUATE.		FRAMINGHAM RESERVOIR. No. 3.	FRAMINGHAM RESERVOIR. No. 2.	ASHLAND RESERVOIR.	HOPKINTON RESERVOIR.	WHITEHALL RESERVOIR.
	Surface.	Bottom.	Surface.	Bottom.	Surface.	Bottom.	Surface.	Mid-depth.	Surface.	Surface.	Surface.
1898,	-	-	354	149	830	696	390	245	263	944	690
1899,	-	-	470	252	905	644	440	218	357	715	393
1900,	-	-	498	361	1,758	1,071	645	365	390	980	437
1901,	-	-	337	225	992	702	336	149	244	450	705
1902,	-	-	590	402	1,071	730	627	204	550	588	198
1903,	-	-	549	388	931	795	459	169	323	231	327
1904,	313	-	517	376	663	542	475	174	153	106	375
1905,	769	592	644	502	1,255	503	535	158	289	240	147
1906,	446	272	953	714	1,407	1,143	692	226	431	475	1,279
1907,	425	212	513	419	1,123	1,200	413	205	378	336	961
1908,	731	466	850	885	1,559	1,241	932	725	699	516	708
1909,	2,151	1,937	2,474	2,513	1,142	1,198	2,372	610	603	294	445
1910,	480	328	464	556	928	1,033	455	436	426	387	154
1911,	649	368	990	988	1,942	2,216	1,140	378	502	457	397
Mean,	746	596	729	624	1,179	980	708	304	407	480	515

NOTE. — A large growth of Asterionella originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE No. 35. — *Microscopic Organisms in Water, etc.* — Concluded.

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WESTON RESERVOIR.	SPOT POND.	CHESTNUT HILL RESERVOIR.			TAPS.			
			SUDBURY AQUEDUCT.	COCHITUATE AQUEDUCT.	EFFLUENT GATE-HOUSE.	Southern Low Service.	Southern High Service.	Northern Low Service.	Northern High Service.
	Surface.	Surface.	Inlet.	Inlet.	No. 2.				
1898,	-	485	304	544	304	230	-	-	-
1899,	-	1,129	359	992	329	192	201	-	-
1900,	-	573	568	1,139	897	468	452	-	-
1901,	-	628	344	697	413	243	280	-	-
1902,	-	581	563	937	525	367	451	-	-
1903,	-	650	450	860	435	286	398	-	-
1904,	-	465	405	838	472	303	470	274	189
1905,	-	609	551	904	554	528	671	363	388
1906,	783	671	631	1,042	721	550	583	326	422
1907,	443	590	349	909	419	312	427	205	422
1908,	979	741	783	1,073	689	666	695	443	481
1909,	2,399	1,079	1,999	632	1,899	1,913	1,959	1,313	677
1910,	625	622	457	-	465	447	421	221	374
1911,	934	748	700	1,382	954	778	735	349	461
Mean,	1,027	684	605	919	648	520	596	437	427

NOTE. — A large growth of Asterionella originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE No. 36. — *Number of Bacteria per Cubic Centimeter in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1911, inclusive.*

[Averages of weekly determinations.]

YEAR.	CHESTNUT HILL RESERVOIR.			SOUTHERN SERVICE TAPS.	
	Sudbury Aqueduct Terminal Chamber.	Cochituate Aqueduct.	Effluent Gate-house No. 2.	Low Service, 244 Boylston Street.	High Service, 1 Ashburton Place.
1898,	207	145	111	96	-
1899,	224	104	217	117	123
1900,	248	113	256	188	181
1901,	225	149	169	162	168
1902,	203	168	121	164	246
1903,	76	120	96	126	243
1904,	347	172	220	176	355
1905,	495	396	489	231	442
1906,	231	145	246	154	261
1907,	147	246	118	130	176
1908,	162	138	137	136	148
1909,	198	229	119	150	195
1910,	216	-	180	178	213
1911,	205	204	151	175	197
Mean,	227	179	188	156	227

TABLE No. 37. — *Colors of Water from Various Parts of the Metropolitan Water Works in 1911. (Means of Weekly Determinations.)*

[Platinum Standard.]

MONTH.	WACHUSETT RESERVOIR.						SUDBURY RESERVOIR.				FRAMINGHAM RESERVOIR.		LAKE COCHITUATE.			
											No. 2.	No. 3.				
	Surface.	Mid-depth.	Bottom.	Worcester Street Bridge.	Quinepoxet River.	Stillwater River.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Mid-depth.	Mid-depth.	Surface.	Mid-depth.	Bottom.	Influent Streams.[1]
January,	10	10	10	39	42	35	10	10	11	11	50	11	19	22	24	27
February,	10	10	10	33	37	31	11	11	11	18	53	12	19	18	22	28
March,	9	9	9	34	37	33	11	11	11	36	43	13	17	20	27	30
April,	8	8	8	34	36	29	11	11	11	62	61	15	17	17	19	30
May,	9	9	9	29	44	38	9	9	9	53	68	11	13	16	17	32
June,	9	9	9	21	44	43	11	11	11	11	58	11	12	14	24	29
July,	8	8	8	16	35	30	9	9	9	9	44	9	10	11	25	23
August,	8	8	8	10	36	22	9	9	10	9	44	9	10	13	95	23
September,	7	7	8	10	34	21	8	8	8	8	61	8	10	13	219	24
October,	7	7	7	12	51	35	8	8	8	8	92	8	11	14	151	22
November,	7	7	7	29	52	39	8	8	8	8	97	10	15	15	40	26
December,	7	7	7	39	46	34	8	8	8	12	87	10	12	12	14	28
Mean,	8	8	8	27	41	33	9	9	10	20	63	11	14	15	56	27

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[1] The colors given in this column represent the combined colors of the waters of the four principal feeders. The color of each is determined monthly, and due weight is given, in combining the results, to the sizes of the streams.

TABLE No. 37. — *Colors of Water, etc.* — Concluded.

[Platinum Standard.]

MONTH.	CHESTNUT HILL RESERVOIR.			SPOT POND.	FELLS RESERVOIR.	NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Inlet (Sudbury Aqueduct).	Inlet (Cochituate Aqueduct).	Effluent Gate-house No. 2.	Mid-depth.	Effluent Gate-house.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 185 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January,	11	-	11	9	9	11	9	11	11
February,	27	19	22	11	10	22	10	22	22
March,	30	17	23	10	10	23	10	23	23
April,	45	18	37	11	11	35	11	25	35
May,	42	-	40	12	11	39	11	30	39
June,	37	-	33	12	12	32	12	26	33
July,	37	11	29	12	12	29	12	22	29
August,	13	10	14	11	11	14	12	12	14
September,	14	10	11	10	10	11	10	10	11
October,	20	12	17	12	12	16	11	12	17
November,	19	-	17	12	12	17	12	14	17
December,	19	12	18	10	10	17	10	14	18
Mean,	26	14	23	11	11	22	11	18	22

TABLE No. 38. — *Temperatures of Water from Various Parts of the Metropolitan Water Works in 1911. (Means of Weekly Determinations.)*

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high water mark.]

[Degrees Fahrenheit.]

MONTH.	WACHUSETT RESERVOIR.			SUDBURY RESERVOIR (DEPTH AT PLACE OF OBSERVATION 54.5 FEET).				FRAMINGHAM RESERVOIR NO. 3 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET).			LAKE COCHITUATE (DEPTH AT PLACE OF OBSERVATION 62.0 FEET).		
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.
January,	32.9	33.5	33.8	35.3	37.1	38.0	34.0	35.7	35.8	35.9	36.2	37.6	38.2
February,	33.5	34.4	34.5	34.0	37.1	38.3	33.6	34.9	35.0	35.1	35.7	37.0	38.0
March,	35.5	36.3	36.3	36.0	38.0	39.0	36.6	37.4	37.5	37.5	37.7	38.0	39.0
April,	39.5	39.5	39.6	41.9	41.8	41.8	44.7	44.3	43.6	43.9	37.5	39.0	39.0
May,	56.9	48.7	47.0	62.1	59.0	56.9	60.6	63.5	61.4	60.4	64.8	53.1	49.3
June,	63.3	50.8	49.2	69.0	67.1	66.3	54.0	67.9	67.7	67.0	67.9	55.4	50.6
July,	77.3	51.5	50.8	79.1	73.4	69.9	57.2	79.0	77.4	75.7	79.3	60.4	56.9
August,	74.9	62.8	56.4	74.6	72.8	70.9	59.1	73.6	73.1	72.6	73.1	58.1	52.3
September,	68.0	55.3	52.8	68.0	67.3	66.4	63.0	66.9	66.9	66.9	66.5	53.9	47.5
October,	58.3	54.4	51.8	55.9	56.2	55.5	53.9	54.8	54.8	54.8	54.0	51.9	46.8
November,	46.4	46.9	46.6	44.0	44.4	44.3	49.8	42.4	43.6	42.4	41.5	44.8	44.1
December,	40.1	40.3	40.1	37.1	37.4	37.4	38.3	36.4	36.4	36.4	37.0	37.8	38.0
Mean,	52.2	46.2	44.9	53.1	52.6	52.1	48.7	53.1	52.8	52.4	52.6	47.3	45.0

TABLE No. 38 — *Temperatures of Water, etc. — Concluded.*

[Degrees Fahrenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.	SPOT POND (DEPTH AT PLACE OF OBSERVATION 28.0 FEET).			NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Effluent Gate-house No. 2.	Surface.	Mid-depth.	Bottom.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 244 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January,	36.3	37.3	37.6	38.0	40.0	39.8	40.7	42.0
February,	36.3	37.4	38.6	38.6	39.0	39.0	41.5	43.0
March,	37.5	39.1	39.5	39.5	38.0	39.5	44.5	43.8
April,	43.7	41.3	41.5	41.6	43.3	42.6	45.3	47.8
May,	59.0	60.6	59.7	54.6	58.1	58.2	61.0	62.4
June,	67.7	68.3	67.4	65.1	65.5	66.8	67.2	68.4
July,	76.2	76.6	74.4	68.6	74.0	75.3	74.1	75.4
August,	73.4	73.2	73.0	71.5	72.2	72.4	72.5	73.3
September,	67.8	67.8	67.6	67.4	66.1	67.0	67.6	68.8
October,	57.9	56.5	56.6	56.6	59.1	57.5	60.8	62.0
November,	49.7	45.1	45.3	45.5	49.0	46.0	49.1	53.1
December,	37.8	37.8	38.3	38.4	43.0	40.1	44.5	47.1
Mean,	53.6	53.4	53.3	52.1	53.9	53.7	55.7	57.3

TABLE No. 39. — *Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1911.*

[Degrees Fahrenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.			FRAMINGHAM.			CLINTON.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
January,	58.0	4.0	30.8	57.0	2.0	30.3	57.0	1.0	27.7
February,	56.0	—0.2	25.8	56.0	—0.6	25.2	54.0	—0.1	22.9
March,	65.0	7.0	34.6	63.0	3.0	33.9	59.0	—0.3	30.9
April,	84.0	19.0	45.5	83.0	17.0	44.1	84.0	17.0	44.4
May,	96.0	29.0	64.1	96.0	29.0	63.4	92.0	30.0	62.2
June,	88.0	48.0	66.0	86.0	47.0	65.4	81.0	48.0	63.6
July,	103.0	53.0	76.0	104.0	49.0	76.0	100.0	55.0	74.7
August,	92.0	49.0	69.0	97.0	46.0	69.0	92.0	52.0	67.9
September,	85.0	34.0	62.2	84.0	30.0	60.7	81.0	34.0	60.0
October,	69.0	27.0	50.8	71.0	24.0	50.6	69.0	27.0	49.7
November,	67.0	20.0	40.8	67.0	20.0	39.8	68.0	20.0	38.2
December,	67.0	14.0	36.6	65.0	14.0	36.2	62.0	13.0	35.3
Average,	-	-	50.2	-	-	49.5	-	-	48.1

TABLE NO. 40. — *Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same, Dec. 31, 1911.*

	DIAMETER OF PIPES IN INCHES.													Total.
	60	48	42	36	30	24	20	16	14	12	10	8	6	
Total length owned and operated Jan. 1, 1911 (feet),	26,652	182,661	8,075	50,347	27,681[1]	59,357	57,311	67,582	26	26,065	3,747	1,825	913	512,242
Gate valves in same,	2	49	-	46	29	49	41	71	1	91	17	14	19	429
Air valves in same,	22	111	3	38	6	29	34	33	-	10	1	-	-	287
Length laid or relaid during 1911 (feet),	2,687	369	-	691	12	10,580	10,016	43	-	173	24	16	18	24,629
Gate valves in same,	1	1	-	4	-	4	9	3	-	5	1	1	-	29
Air valves in same,	3	1	-	4	1	7	6	-	-	-	-	-	-	22
Length abandoned during 1911 (feet),	5	334	-	70	78	6	-	-	-	9	3	-	-	505
Gate valves in same,	-	1	-	-	1	3	-	-	-	-	-	-	-	5
Air valves in same,	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Length owned and operated Jan. 1, 1912 (feet),	29,334[2]	182,696	8,075	50,968	27,615[1]	69,931	67,327	67,625	26	26,229	3,768	1,841	931	536,366[3]
Gate valves in same,	3	49	-	50	28	50	50	74	1	96	18	15	19	453
Air valves in same,	25	111	3	42	7	36	40	33	-	10	1	-	-	308

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[1] Includes 11,180 feet of 30-inch mortar lined and covered wrought iron pipe.

[2] Includes 2,035 feet of 76-inch concrete lined pressure tunnel and 363 feet of 76-inch mortar lined and concrete covered steel pipe and 21 feet of 76-inch cast iron pipe.

[3] 101.58 miles.

Table No. 41. — *Statement of Cast-iron Hydrant, Blow-off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1911.*

	Diameter of Pipes in Inches.								Total.
	24	20	16	12	10	8	6	4	
Total length in use Dec. 31, 1911 (feet),	352	293	2,371	4,816	173	351	3,120	1,439	12,915[1]
Total valves in use Dec. 31, 1911,	-	-	22	87	1	2	75	44	231

[1] 2.45 miles.

TABLE No. 42. — *Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1911.*

BY WHOM OWNED.	INCHES.																				TOTAL.	
	60	48	42	40	36	30	28	24	20	18	16	14	13	12	10	8	7	6	5	4	Feet.	Miles.
Metropolitan Water Works,	29,334	182,696	8,075	-	50,968	27,615	-	69,931	67,327	-	67,625	26	-	26,229	3,768	1,841	-	931	-	-	536,366	101.58
Boston,	-	39,175	16,813	23,104	46,584	98,937	244	77,482	95,017	-	222,589	-	-	1,280,874	315,529	671,386	-	1,238,397	-	64,470	4,090,601	774.73
Somerville,	-	-	-	-	-	-	-	-	3,634	367	3,501	8,037	-	83,404	51,593	100,578	-	204,322	-	20,369	475,805	90.11
Malden,	-	-	-	-	-	-	-	-	-	-	-	9,152	-	70,640	27,595	78,717	-	215,285	-	61,147	462,536	87.60
Chelsea,	-	-	-	-	-	-	-	-	-	-	5,176	-	-	4,974	39,820	27,610	-	137,634	-	7,005	222,219	42.09
Everett,	-	-	-	-	-	-	-	2,484	2,900	-	4,214	806	-	5,570	40,942	23,129	-	136,183	-	30,600	246,828	46.75
Quincy,	-	-	-	-	-	-	-	-	2,679	-	23,232	-	-	26,654	37,534	106,253	994	285,923	948	107,631	591,848	112.09
Medford,	-	-	-	-	-	-	-	-	673	-	6,775	9,598	-	27,026	38,557	80,629	-	113,949	-	31,387	308,594	58.45
Melrose,	-	-	-	-	-	-	-	-	-	-	5,223	2,920	-	22,156	19,846	24,249	-	134,231	-	53,136	261,761	49.58
Revere,[1]	-	-	-	-	-	-	-	-	-	-	23,265	4,500	1,200	19,025	13,900	18,786	-	66,898	-	80,316	227,890	43.16
Watertown,	-	-	-	-	-	-	-	-	-	-	400	11,877	-	5,959	6,164	20,371	-	122,257	-	12,666	179,694	34.03
Arlington,	-	-	-	-	-	-	-	-	-	-	-	-	-	31,804	23,120	32,802	-	99,578	-	22,603	209,907	39.76
Milton,	-	-	-	-	-	-	-	-	-	-	103	44	-	22,548	20,935	51,826	-	128,650	-	16,885	240,991	45.64
Winthrop,	-	-	-	-	-	-	-	-	-	-	-	-	-	4,049	23,367	31,213	-	40,907	-	61,789	161,325	30.55
Stoneham,	-	-	-	-	-	-	-	-	-	-	-	-	-	4,525	4,725	4,543	-	96,734	-	13,810	124,337	23.55
Belmont,	-	-	-	-	-	-	-	-	-	-	-	-	-	1,771	14,324	21,079	-	85,030	-	235	122,439	23.19
Lexington,	-	-	-	-	-	-	-	-	-	-	-	-	-	9,000	2,669	17,915	-	84,769	-	34,548	148,901	28.20
Nahant,	-	-	-	-	-	-	-	-	-	-	-	4,000	-	150	11,550	4,800	-	36,800	-	55,200	112,500	21.31
Swampscott,	-	-	-	-	-	-	-	-	-	-	-	-	-	7,390	14,041	9,738	-	60,807	-	9,025	101,001	19.13
Total feet,	29,334	221,871	24,888	23,104	97,552	126,552	244	149,897	172,230	367	362,103	50,960	1,200	1,653,748	609,979	1,327,465	994	3,289,285	948	682,822	8,825,543	-
Total miles,	5.55	42.02	4.71	4.38	18.48	23.97	0.05	28.39	32.62	0.07	68.58	9.65	0.23	313.21	115.52	251.41	0.19	622.97	0.18	129.32	-	1,671.50

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[1] Includes small portion of Saugus.

TABLE No. 43. — *Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1911, and the Number of Services and Meters installed during the Year 1911.*

CITY OR TOWN.	Services.	Meters.	Fire Hydrants.	Services Installed.	Meters Installed.
Boston,	95,037	25,975	8,234	1,441	7,565
Somerville,	12,259	6,526	1,082	137	770
Malden,	7,632	7,314	482	197	177
Chelsea,	4,510	4,252	356	80	1,172
Everett,	5,466	1,560	537	159	377
Quincy,	7,746	4,801	873	444	2,167
Medford,	4,563	4,542	567	175	353
Melrose,	3,620	3,863	327	37	87
Revere,[1]	3,662	1,268	203	208	377
Watertown,	2,156	2,130	343	114	60
Arlington,	2,181	1,536	414	141	248
Milton,	1,510	1,510	367	74	74
Winthrop,	2,553	2,487	237	84	101
Stoneham,	1,491	826	118	36	193
Belmont,	1,008	1,008	198	103	103
Lexington,	883	615	148	48	140
Nahant,	559	284	81	37	57
Swampscott,	1,535	1,535	151	66	79
Total,	158,371	72,032	14,718	3,581	14,100

[1] Includes small portion of Saugus.

TABLE No. 44. — *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, to which Water rose at Different Stations on the Metropolitan Water Works in 1911.*

1911. MONTH.	LOW SERVICE.														SOUTHERN HIGH SERVICE.			
	BOSTON ENGINE HOUSE, BULFINCH STREET.		ALLSTON ENGINE HOUSE, HARVARD STREET.		MEDFORD, MYSTIC RESERVOIR.		MEDFORD CITY HALL ANNEX, HIGH STREET.		SOMERVILLE CITY HALL ANNEX, WALNUT STREET.		MALDEN WATER WORKS SHOP, GREEN STREET.		CHELSEA COURT HOUSE.		BOSTON METROPOLITAN WATER WORKS OFFICE, 1 ASHBURTON PLACE.		WATERTOWN WATER WORKS OFFICE, MAIN STREET.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January, .	132	122	181	171	168	163	168	163	168	162	163	160	163	155	248	236	262	256
February, .	130	119	181	172	167	163	167	162	167	162	164	160	164	155	249	237	262	257
March, . .	135	125	181	172	166	163	164	158	167	162	166	161	165	157	250	236	262	256
April, . .	139	126	179	171	166	163	164	159	168	162	165	162	165	157	249	236	264	256
May, . .	140	126	184	176	166	162	164	159	166	159	165	159	165	153	248	234	261	249
June, . .	144	126	184	178	166	162	166	162	169	163	166	160	166	154	246	232	261	246
July, . .	141	123	183	175	167	162	167	162	167	162	165	159	166	156	247	231	261	243
August, .	148	126	182	173	168	164	168	164	168	164	166	162	166	158	248	234	261	255
September, .	151	128	176	170	166	163	166	163	166	162	165	162	165	157	248	234	264	259
October, .	152	127	176	170	167	164	167	164	167	162	166	163	166	158	248	234	264	260
November, .	161	136	175	169	167	163	167	163	165	160	166	164	164	156	249	236	264	260
December, .	164	141	174	168	167	163	167	163	167	162	165	163	165	158	249	236	264	260
Averages,	145	127	180	172	167	163	166	162	167	162	165	161	165	156	248	235	263	255

TABLE No. 44. — *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, etc.* — Concluded.

1911.	Southern High-service — Concluded.								Northern High-service.										Northern Extra High-service.	
	BELMONT WATER WORKS SHOP, WAVERLEY STREET.		MILTON WATER WORKS OFFICE, ADAMS STREET.		FORBES HILL TOWER, QUINCY.		QUINCY WATER WORKS SHOP.		SOMERVILLE PUMPING STATION, CEDAR STREET.		MALDEN CITY HALL.		REVERE WATER WORKS OFFICE, BROADWAY.		LYNN ENGINE HOUSE, UNION SQUARE.		WINTHROP TOWN HALL, HERMAN STREET.		LEXINGTON TOWN HALL, MASSACHUSETTS AVENUE.	
MONTH.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January,	262	253	247	235	238	230	237	216	268	255	270	266	267	259	265	260	192	181	384	367
February,	261	253	246	236	241	232	239	217	268	255	271	266	267	260	264	260	191	176	386	370
March,	262	253	244	232	243	232	241	217	268	256	271	266	268	260	262	258	183	172	413[1]	389[1]
April,	264	252	242	231	242	230	240	216	269	254	272	266	268	260	265	259	181	171	387	368
May,	261	241	241	227	238	224	238	207	268	244	269	263	264	254	261	246	186	171	386	363
June,	261	242	240	225	238	223	236	204	268	245	268	263	261	250	260	243	189	173	384	363
July,	261	224	244	223	242	219	238	195	267	236	268	261	263	245	257	224	188	164	385	359
August,	261	242	250	236	244	230	241	211	267	252	268	262	264	252	260	243	186	170	385	375
September,	264	254	250	236	245	230	242	213	267	252	270	263	265	257	262	253	188	174	385	375
October,	264	254	249	234	242	226	237	207	266	251	271	265	268	260	265	259	187	174	384	369
November,	262	252	248	233	241	228	236	213	267	251	271	266	269	261	266	260	191	177	385	372
December,	264	254	248	233	242	228	237	214	270	253	272	267	269	261	265	259	190	177	385	364
Averages,	262	248	246	232	241	228	239	211	268	250	270	265	266	257	263	252	188	173	387	370

[1] Direct pressure for thirteen days while repairing pressure regulator.

APPENDIX No. 3.

WATER WORKS STATISTICS FOR THE YEAR 1911.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns: —

CITY OR TOWN.	Population, Census of 1910.	Estimated Population, July 1, 1911.
Boston,	670,585	688,520
Somerville,	77,236	79,360
Malden,	44,404	45,780
Chelsea,	32,452	33,630
Newton,[1]	39,806	40,870
Everett,	33,484	34,910
Quincy,	32,642	33,760
Medford,	23,150	24,100
Hyde Park,[1]	15,507	15,910
Melrose,	15,715	16,070
Revere,	18,219	19,240
Watertown,	12,875	13,330
Arlington,	11,187	11,700
Milton,	7,924	8,140
Winthrop,	10,132	10,670
Stoneham,	7,090	7,360
Swampscott,	6,204	6,390
Lexington,	4,918	5,090
Belmont,	5,542	5,840
Nahant,	1,184	1,260
Total population of Metropolitan Water District,	1,070,256	1,101,930
Saugus,[2]	280	280

[1] No water supplied to these places during the year from Metropolitan Water Works.

[2] Only a small portion of Saugus is supplied with water.

Mode of Supply.

27 per cent. by gravity.
73 per cent. by pumping.

Pumping.

Chestnut Hill Pumping Station, No. 1: —

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used: — Bituminous: Beaver Run and Sonman. Anthracite: buckwheat. Price per gross ton in bins: bituminous $3.98 to $4.06, buckwheat $2.88. Average price per gross ton $3.81. Per cent. ashes, 12.3.

Chestnut Hill Pumping Station, No. 2: —

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used: — Bituminous: Beaver Run, South Fork, Atlas, Dunlo, Logan, New River, and Spangler No. 4. Anthracite: buckwheat. Price per gross ton in bins: bituminous $3.82 to $3.95, buckwheat $2.69. Average price per gross ton $3.60. Per cent. ashes, 12.6.

Spot Pond Station: —

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used: — Bituminous: Pocahontas and New River. Anthracite: screenings. Price per gross ton in bins: bituminous $4.35 to $4.91, screenings $2.50. Average price per gross ton $3.61. Per cent. ashes, 12.9.

	CHESTNUT HILL PUMPING STATIONS —		
	No. 1.		No. 2.
	Engines Nos. 1 and 2.	Engine No. 4.	Engine No. 12.
Daily pumping capacity (gallons),	16,000,000	30,000,000	40,000,000
Coal consumed for year (pounds),	1,169,770	4,428,994	3,626,115
Cost of pumping, figured on pumping station expenses,	$4,994.27	$19,842.51	$15,719.90
Total pumpage for year, corrected for slip (million gallons),	671.54	5,804.62	5,352.11
Average dynamic head (feet),	128.14	127.77	123.34
Gallons pumped per pound of coal,	574.08	1,310.60	1,475.99
Duty on basis of plunger displacement,	63,190,000	142,290,000	154,730,000
Cost per million gallons raised to reservoir,	$7.437	$3.418	$2.937
Cost per million gallons raised one foot,	.0580	.0268	.0238

	CHESTNUT HILL PUMPING STATION No. 2.	SPOT POND STATION.
	Engines Nos. 5, 6 and 7.	Engines Nos. 8 and 9.
Daily pumping capacity (gallons),	105,000,000	30,000,000
Coal consumed for year (pounds),	6,597,460	2,442,415
Cost of pumping, figured on pumping station expenses,	$30,773.67	$13,283.03
Total pumpage for year, corrected for slip (million gallons),	17,530.71	2,770.22
Average dynamic head (feet),	46.34	133.36
Gallons pumped per pound of coal,	2,657.19	1,134.21
Duty on basis of plunger displacement,	104,680,000	128,560,000
Cost per million gallons raised to reservoir,	$1.755	$4.795
Cost per million gallons raised one foot,	.0379	.0359

Consumption.

Estimated total population of the nineteen cities and towns supplied wholly or partially during the year 1911,	1,046,630
Total consumption (gallons), pump basis,	40,316,390,000
Average daily consumption (gallons), pump basis,	110,456,000
Gallons per day to each inhabitant, pump basis,	105.5

Distribution.

	Owned and operated by Metropolitan Water and Sewerage Board.	Total in District supplied by Metropolitan Water Works.
Kinds of pipe used,	–[1]	–[2]
Sizes,	60 to 6 inch.	60 to 4 inch.
Extensions, less length abandoned (miles),	4.56	38.13
Length in use (miles),	101.58	1,671.50
Stop gates added,	24	-
Stop gates now in use,	453	-
Service pipes added,	-	2,683
Service pipes now in use,	-	158,319
Meters added,	-	13,563
Meters now in use,	-	72,025
Fire hydrants added,	-	125
Fire hydrants now in use,	-	14,718

[1] Cast-iron, cement-lined wrought iron and cement-lined steel pipe.

[2] Cast-iron, cement-lined wrought iron, cement-lined steel and kalamine pipe.

APPENDIX No. 4.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID. 4. Next to Lowest.	5. Lowest.	6. Contractor.
1	68[1]	Additions to the pumping plant at Deer Island, Boston Harbor.	4	$69,230 00[2]	$51,990 00	Allis-Chalmers Co., Milwaukee, Wis.
2	73	Additions to the pumping plant at East Boston.	1	-	37,000 00[2]	Allis-Chalmers Co., Milwaukee, Wis.
3	81	Section 66, extension of North Metropolitan System in Broadway, Malden to Everett.	8	16,531 38	16,184 00[2]	A. G. Tomasello, Boston.
4	82[1]	4,400 tons of coal: — 3,000 tons for East Boston pumping station. 1,000 tons for Charlestown pumping station. 400 tons for Alewife Brook pumping station.	 6 3 2	 $4.12 per ton. $4.09 per ton. $4.85 per ton.	 $4.10 per ton.[2] $3.90 per ton.[2] $4.55 per ton.[2]	New England Coal and Coke Co., Boston.
5	83[1]	2,600 tons of coal for Deer Island pumping station.	3	$4.22 per ton.	$4.20 per ton.[2]	Metropolitan Coal Co., Boston.
6	89[1]	Steam, blow-off, feed water and condenser piping at East Boston pumping station.	7	$5,553 00	$5,400 00[2]	Lumsden & Van Stone Co., Boston.
7	90	4,250 tons of coal: — 2,900 tons for East Boston pumping station. 1,000 tons for Charlestown pumping station. 350 tons for Alewife Brook pumping station.	 3 3 2	 $3.79 per ton. $3.86 per ton. $4.60 per ton.	 $3.725 per ton.[2] $3.725 per ton.[2] $4.35 per ton.[2]	New England Coal and Coke Co., Boston.
8	91	2,600 tons of coal for Deer Island pumping station.	4	$3.92 per ton.	$3.92 per ton.[2]	Staples Coal Co., Boston.
9	93[1]	Covering for boilers, smoke flues, heater, piping and accessories at East Boston pumping station.	5	$2,323 00	$2,236 00[2]	The Philip Carey Co., Boston.

[1] Contract completed.

[2] Contract based upon this bid.

APPENDIX No. 4.

THE YEAR 1911 — SEWERAGE WORKS.

North Metropolitan System.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1911.	10. Value of Work done Dec. 31, 1911.	
Nov. 2, 1908	-	- -	$69,230 00	1
June 5, 1909	Dec. 27, 1911	- -	33,300 00	2
July 27, 1910	Dec. 6, 1911	For earth excavation and refilling in trench for 18-inch and 12-inch vitrified pipe sewer, $4 per lin. ft.; for Portland cement brick masonry in manholes, $16 per cu. yd.; for Portland cement concrete masonry in trench, $7 per cu. yd.; for rock excavation, as found, $6 per cu. yd.	17,553 74	3
July 25, 1910	June 1, 1911	- -	15,514 86	4
July 25, 1910	June 1, 1911	- -	10,508 52	5
Mar. 15, 1911	Aug. 19, 1911	For furnishing and erecting steam, blow-off, feed water and condenser piping at East Boston pumping station.	5,400 00	6
July 5, 1911	-	$3.725 per ton of 2,240 lbs. delivered in bins at East Boston pumping station. $3.725 per ton of 2,240 lbs. delivered in bins at Charlestown pumping station. $4.35 per ton of 2,240 lbs. delivered in bins at Alewife Brook pumping station.	7,570 35	7
July 5, 1911	-	$3.92 per ton of 2,240 lbs. delivered in bins at Deer Island pumping station.	4,936 49	8
July 24, 1911	Sept. 30, 1911	For furnishing and placing magnesia covering for six vertical boilers, smoke flues, heater, piping and accessories for East Boston pumping station.	2,236 00	9

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

	1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID. 4. Next to Lowest.	AMOUNT OF BID. 5. Lowest.	6. Contractor.
1	83[1]	500 tons of coal for Nut Island screen-house.	4	$4.24 per ton.	$4.20 per ton.[2]	Metropolitan Coal Co., Boston.
2	84[1]	2,300 tons of coal for Ward Street pumping station.	3	$4.45 per ton.	$4.29 per ton.[2]	Staples Coal Co., Boston.
3	85[1]	400 tons of coal for Quincy pumping station.	3	$4.80 per ton.	$4.50 per ton.[2]	Frost Coal Co., Dorchester.
4	87[1]	Receiving basin, foundations and appurtenances for sewage lifting station, Hough's Neck, Quincy.	8	$10,800 00	$9,371 00[2]	John Cashman & Sons Company, Quincy.
5	88[1]	Sewage lifting station building, Hough's Neck, Quincy.	6	1,760 00	1,725 00[2]	C. A. Dodge Company, Cambridge.
6	91	2,350 tons of coal: — 1,900 tons for Ward Street pumping station. 450 tons for Nut Island screen-house.	 4 3	 $3.95 per ton. $4.03 per ton.	 $3.92 per ton.[2] $4.02 per ton.[2]	Staples Coal Co., Boston.
7	92	375 tons of coal for Quincy pumping station.	3	$4.75 per ton.	$4.45 per ton.[2]	Neponset Coal Co., Dorchester.

[1] Contract completed.

[2] Contract based upon this bid.

THE YEAR 1911 — SEWERAGE WORKS — *Continued.*

South Metropolitan System.

7. Date of Contract.	8. Date of Completion of Work.	9. Prices of Principal Items of Contracts made in 1911.	10. Value of Work done Dec. 31, 1911.	
July 25, 1910	June 1, 1911	- -	$1,650 00	1
July 25, 1910	June 1, 1911	- -	6,427 10	2
July 25, 1910	June 1, 1911	- -	1,179 79	3
Aug. 29, 1910	May 13, 1911	- -	9,501 64	4
Nov. 14, 1910	Mar. 21, 1911	- -	1,725 00	5
July 5, 1911	-	$3.92 per ton of 2,240 lbs. delivered in bins at Ward Street pumping station. $4.02 per ton of 2,240 lbs. delivered on wharf at Nut Island screen-house.	4,095 22	6
July 5, 1911	-	$4.45 per ton of 2,240 lbs. delivered in bins at Quincy pumping station.	745 07	7

CONTRACTS MADE AND PENDING DURING THE YEAR 1911 — SEWERAGE WORKS — *Concluded.*

Summary of Contracts.[1]

	Value of Work done Dec. 31, 1911.
North Metropolitan System, 9 contracts, ...	$166,244 96
South Metropolitan System, 7 contracts, ...	25,323 82
Total of 16 contracts made and pending during the year 1911, ...	$191,568 78

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[1] In this summary the cost of day work and contracts charged to maintenance are excluded.

APPENDIX No. 5.

FINANCIAL STATEMENT PRESENTED TO THE GENERAL COURT ON JANUARY 10, 1912.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its doings, receipts, expenditures, disbursements, assets and labilities for the year ending November 30, 1911, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

METROPOLITAN WATER WORKS.

Construction.

The loans authorized for expenditures under the Metropolitan Water acts, the receipts which are added to the loan fund, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1911, have been as follows: —

Loans authorized under Metropolitan Water acts, . . .		$42,090,000 00
Receipt from town of Swampscott for admission to Metropolitan Water District, paid into Loan Fund (St. 1909, c. 320), . .		90,000 00
Receipts from the sales of property which are placed to the credit of the Metropolitan Water Loan Fund: —		
For the year ending November 30, 1911, .	$24,674 02	
For the period prior to December 1, 1910, .	175,779 50	
		200,453 52
		$42,380,453 52
Amount approved for payment by the Board out of the Metropolitan Water Loan Fund: —		
For the year ending November 30, 1911, .	$445,281 57	
For the period prior to December 1, 1910,	41,479,746 91	
		41,925,028 48
Balance December 1, 1911, ...		$455,425 04

The amount of the Metropolitan Water Loan bonds issued and outstanding at the beginning of the fiscal year was $41,398,000. At the end of the year the amount of the loans was $41,738,000. The Metropolitan Water Loan Sinking Fund amounted at the beginning of the year to $8,070,383.46, and at the end of the year to $8,927,838.95. The net decrease in the debt for the Metropolitan Water Works was $517,455.49.

Maintenance.

Amount appropriated for the maintenance and operation of works, for the year ending November 30, 1911,	$419,800 00	
Balance of special appropriation for the improvement of the Cochituate watershed (1909–1910) remaining,	13,307 38	
Receipts credited to this fund for year ending November 30, 1911,	25,328 57	
		$458,435 95
Amount approved by Board for maintenance and operation of works during year ending November 30, 1911,		380,036 25
Balance December 1, 1911,		$78,399 70

This balance includes the sum of $1,441.98 appropriated for the improvement of the Cochituate watershed which remains to be expended for the completion of the work. There is also included in the balance the sum of $15,000 appropriated for the protection of the water supply in Newton, which work is to be undertaken in the current year.

The Board has also received during the year ending November 30, 1911, $33,890.69 from rentals, land products and other proceeds from the operations of the Board which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works, in reduction of the amount to be assessed upon the Metropolitan Water District for the year.

Sums received from sales of water to municipalities not belonging to the District and to water companies, and from municipalities for admission to the District, have been applied as follows: —

For the period prior to December 1, 1906, distributed to the cities and towns of the District, as provided by section 3 of the Metropolitan Water Act,	$219,865 65
For the period beginning December 1, 1906, and prior to December 1, 1910, applied to the Metropolitan Water Loan Sinking Fund, as provided by chapter 238 of the Acts of 1907,	20,649 35
For the year beginning December 1, 1910, and ending November 30, 1911, applied to the Metropolitan Water Loan Sinking Fund, as provided by said last-named act,	6,137 74
	$246,652 74

METROPOLITAN SEWERAGE WORKS.

Construction.

The loans authorized under the various acts of the Legislature for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of the loans, and the expenditures for construction, are given below, as follows: —

North Metropolitan System.

Loans authorized for expenditures for construction under the various acts, including those for the Revere, Belmont and Malden extensions and North System enlargement and extension,	$6,635,865 73	
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System: —		
For the year ending November 30, 1911,	1,168 86	
For the period prior to December 1, 1910,	63,391 78	
Amount approved for payment by the Board[1] out of the Metropolitan Sewerage Loan Fund, North System: —		
For the year ending November 30, 1911,		$181,624 28
For the period prior to December 1, 1910,		6,498,237 94
	$6,700,426 37	$6,679,862 22
Balance December 1, 1911,		$20,564 15

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[1] The word "Board" refers to the Metropolitan Sewerage Commission and its successor the Metropolitan Water and Sewerage Board.

South Metropolitan System.

Loans authorized for expenditures for construction under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extension, ...	$8,867,046 27	
Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: —		
For the year ending November 30, 1911, . .	2,225 69	
For the period prior to December 1, 1910, .	11,406 82	
Amount approved by the Board for payment as follows: —		
On account of the Charles River valley sewer,		$800,046 27
On account of the Neponset valley sewer, .		911,531 46
On account of the High-level sewer and extension: —		
For the year ending November 30, 1911, .		20,904 63
For the period prior to December 1, 1910,		7,080,502 40
	$8,880,678 78	$8,812,984 76
Balance December 1, 1911, ...		$67,694 02

The loans for the Metropolitan Sewerage Works outstanding at the beginning of the fiscal year amounted to $15,440,912, and at the end of the year to $15,502,912. The amount of the Metropolitan Sewerage Sinking Fund was at the beginning of the fiscal year $1,929,528.07, and at the end of the year was $2,180,653.98. The net decrease in the debt for the Metropolitan Sewerage Works was $189,125.91.

Maintenance.

North Metropolitan System.

Appropriated for the year ending November 30, 1911, . . .	$152,800 00
Balance of special appropriation for the restoration and equipment of the East Boston pumping station (1908), remaining, . .	849 43
Receipts from pumping and from other sources, which are returned to the appropriation: —	
For the year ending November 30, 1911, ...	376 23
	$154,025 66
Amount approved for payment by the Board: —	
For the year ending November 30, 1911, ...	149,717 64
Balance December 1, 1911, ...	$4,308 02

South Metropolitan System.

Appropriated for the year ending November 30, 1911,	$101,800 00
Receipts from sales of property and for pumping, which are returned to the appropriation: —	
For the year ending November 30, 1911,	358 61
	$102,158 61
Amount approved for payment by the Board: —	
For the year ending November 30, 1911,	100,094 61
Balance December 1, 1911,	$2,064 00

APPENDIX NO. 6.

LEGISLATION OF THE YEAR 1911 AFFECTING THE METROPOLITAN WATER AND SEWERAGE BOARD.

ACTS OF 1911.

CHAPTER 5.

AN ACT RELATIVE TO THE ISSUING OF METROPOLITAN WATER LOAN BONDS.

Be it enacted, etc., as follows:

Metropolitan water loan bonds.

SECTION 1. All bonds hereafter issued under authority of section seventeen of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, or of acts in amendment thereof or in addition thereto, may be issued as registered bonds or with interest coupons attached.

Repeal.

SECTION 2. All acts and parts of acts inconsistent herewith are hereby repealed.

SECTION 3. This act shall take effect upon its passage. [*Approved January 19, 1911.*

CHAPTER 21.

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO USE CERTAIN FUNDS FOR EXTENDING THE SOUTH METROPOLITAN SEWER TO THE TOWN OF BRAINTREE.

Be it enacted, etc., as follows:

Board authorized to use funds for extension of the South Metropolitan sewer to the town of Braintree.

SECTION 1. The metropolitan water and sewerage board is hereby authorized to expend any balance of the proceeds of the bonds already issued on account of the Metropolitan Sewerage Loan Fund, which may be in excess of the amount required for satisfying the purposes for which such bonds were issued, to meet any expenses which may be incurred under the provisions of chapter five hundred and forty-six of the acts of the year nineteen hundred and ten to provide for the addition of the town of Braintree to the south metropolitan sewerage district.

SECTION 2. This act shall take effect upon its passage. [*Approved February 9, 1911.*

CHAPTER 291.

AN ACT TO PROVIDE FOR THE PROTECTION OF THE PUBLIC HEALTH IN THE VICINITY OF THE TOWNS OF WINCHESTER AND STONEHAM AND THE CITY OF WOBURN.

Be it enacted, etc., as follows:

SECTION 1. The state board of health is hereby authorized and directed to prohibit the entrance or discharge of sewage into any part of Aberjona river, or its tributaries, and to prevent the entrance or discharge therein of any other substance which might be injurious to public health or might tend to create a public nuisance.

State board of health authorized to prohibit entrance of sewage into Aberjona river.

SECTION 2. The board shall consult and advise with the owner of any factory or other establishment situated on or near the said river or any of its tributaries, at his request or of its own motion, as to the best practicable and reasonably available means of rendering the waste or refuse therefrom harmless.

Board of health to consult with owner of factories, etc.

SECTION 3. The supreme judicial court or any justice thereof, and the superior court or any justice thereof, shall have jurisdiction in equity to enforce the provisions of this act, and any order made by the state board of health in conformity therewith. Proceedings to enforce any such order shall be instituted and prosecuted by the attorney-general upon the request of the state board of health.

Jurisdiction of court.

SECTION 4. Whoever permits the entrance or discharge into any part of Aberjona river, or its tributaries, of sewage or of any other substance injurious to public health or tending to create a public nuisance shall be punished by a fine not exceeding five hundred dollars for each offence.

Penalty for permitting entrance of sewage, etc., into Aberjona river.

SECTION 5. This act shall take effect on the first day of July in the year nineteen hundred and eleven. [*Approved April 14, 1911.*

CHAPTER 464.

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO EXTEND THE SOUTHERN HIGH SERVICE WATER SYSTEM TO THE TOWN OF HYDE PARK.

Be it enacted, etc., as follows:

Appropriation for extending the metropolitan water works to the town of Hyde Park.

SECTION 1. The sum of two hundred and twelve thousand dollars shall be allowed and paid out of the treasury of the commonwealth from the Metropolitan Water Loan Fund for the extension of the southern high service of the metropolitan water works for the supply of water to the town of Hyde Park.

Metropolitan water loan.

SECTION 2. For the purposes aforesaid the metropolitan water and sewerage board may, in addition to providing for the improvements for which expenditures have hitherto been authorized, expend any sum heretofore appropriated for the construction of the metropolitan water works. To meet the further expenditures incurred under the provisions of this act, and not so provided for, the treasurer and receiver general shall, from time to time, issue upon the request of said board, bonds in the name and behalf of the commonwealth, to be designated on the face thereof, Metropolitan Water Loan, to an amount not exceeding two hundred and twelve thousand dollars, in addition to the sum of forty-one million eight hundred and seventy-eight thousand dollars authorized to be issued by chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five and acts in amendment thereof and in addition thereto, and the provisions of said chapter four hundred and eighty-eight and of acts in amendment thereof and in addition thereto shall apply to this additional loan.

SECTION 3. This act shall take effect upon its passage. [*Approved May 18, 1911.*

CHAPTER 494.

AN ACT TO CONSTITUTE EIGHT HOURS A DAY'S WORK FOR PUBLIC EMPLOYEES.

Be it enacted, etc., as follows:

Eight hours to constitute a day's work for public employees.

SECTION 1. The service of all laborers, workmen and mechanics, now or hereafter employed by the commonwealth or by any county therein or by any city or town which has accepted the provisions of section twenty of chapter one hundred and six of the Revised Laws, or of section forty-two of chapter five hundred and fourteen of the acts of the year nineteen hundred and nine, or by any contractor or sub-contractor for or upon any public works of the commonwealth or of any county therein or of any such city or town, is hereby restricted to eight hours in any one calendar day, and it shall be unlawful for any officer of the commonwealth or of any county therein, or of any such city or town, or for any such contractor or sub-contractor or other person whose duty it shall be to employ, direct or control the service of such laborers, workmen or mechanics to require or permit any such laborer, workman or mechanic to work more than eight hours in any one calendar day, except in cases of extraordinary emergency. Danger to property, life, public safety or public health only shall be considered cases of extraordinary emergency within the meaning of this section. In cases where a Saturday half holiday is given the hours of labor upon the other working days of the week may be increased sufficiently to make a total of forty-eight hours for the week's work. Threat of loss of employment or to obstruct or prevent the obtaining of employment or to refrain from employing in the future, shall each be considered to be "requiring" within the meaning of this section. Engineers shall be regarded as mechanics within the meaning of this act.

SECTION 2. Every contract, excluding contracts for the purchase of material or supplies, to which the commonwealth or any county therein or any city or town which has accepted the provisions of section twenty of chapter one hundred and six of the Revised Laws, is a party which may involve the employment of laborers, workmen or mechanics shall contain a stipulation that no laborer, workman or mechanic working within this commonwealth, in the employ of the contractor, sub-contractor or other person doing or contracting to do the whole or a part of the work contemplated by the contractor shall be requested or required to work more than eight hours in any one calendar day, and every such contract which does not contain this stipulation shall be null and void. **Contracts.**

SECTION 3. Any agent or official of the commonwealth or of any county therein or of any city or town or any contractor or sub-contractor or any agent or person acting on behalf of any contractor or sub-contractor who violates any provision of this act shall be punished by a fine not exceeding one thousand dollars or by imprisonment for six months or both such fine and imprisonment for each offence. **Penalty.**

Not to apply in certain cases.

SECTION 4. This act shall not apply to the preparation, printing, shipment and delivery of ballots to be used at a caucus, primary, state, city or town election, nor during the sessions of the general court to persons employed in legislative printing or binding; nor shall it apply at any time to persons employed in any state, county or municipal institution, on a farm, or in the care of the grounds, in the stable, in the domestic or kitchen and dining-room service or in store rooms or offices.

Repeal.

SECTION 5. All acts and parts of acts inconsistent herewith are hereby repealed. [*Approved May 27, 1911.*

CHAPTER 512.

AN ACT TO PROVIDE FOR AN OUTLET FOR THE SEWAGE OF THE CITIES OF EVERETT AND MALDEN INTO THE NORTH METROPOLITAN SEWERAGE SYSTEM.

Be it enacted, etc., as follows:

Additional outlet for the sewage of Malden and Everett to be provided.

SECTION 1. The metropolitan water and sewerage board may, in order to provide an additional outlet for the sewage of the cities of Malden and Everett, acting in behalf of the commonwealth, take, or acquire by purchase or otherwise, the existing sewer belonging to the city of Malden from a point at or near the corner of Eastern avenue and Bryant street in said city and running northerly through Eastern avenue to a point at or near the middle of Broadway; and the said board is hereby authorized to pay to the city of Malden the actual cost of the construction of the portion of the sewer so taken. The said portion of the sewer when so taken shall become a part of the north metropolitan system of sewers. Upon acquiring the portion of the sewer in Eastern avenue as aforesaid the said board shall proceed to construct a sewer extending from said sewer through Broadway to a point at or near the boundary line between the cities of Malden and Everett, and the sewer so constructed shall become a part of the north metropolitan system. The city of Everett may, under the direction of said board, connect its local system of sewers with the said metropolitan sewer in Broadway. The city of Malden may, under the direction of said board, connect its local system of sewers with the said metropolitan sewers in Broadway and Eastern avenue and may also, subject to such direction, make and maintain house connections with the said sewer. The city of Malden is hereby authorized and empowered to make, levy and collect for its own benefit assessments of annual rates, or sums in lieu thereof, for said sewers in Broadway and Eastern avenue in the same manner in which sewer assessments are now made, levied and collected for its local sewers.

The metropolitan water and sewerage board to exercise certain authority, etc.

SECTION 2. For the purpose of taking and constructing said metropolitan sewers in Eastern avenue and Broadway and for the operation and maintenance thereof, the said board, acting in behalf of the commonwealth, shall have and exercise all the authority conferred upon it by chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and all acts in amendment thereof and in addition thereto, and all the provisions of said acts are made applicable to the taking, construction, maintenance and operation of said sewers except as is otherwise provided herein.

Metropolitan Sewerage Loan.

SECTION 3. To meet the expenses incurred under the provisions of this act the treasurer and receiver general shall, from time to time, issue in the name and behalf of the commonwealth and under its seal bonds designated on the face thereof, Metropolitan Sewerage Loan, for a term not exceeding thirty years, to an amount not exceeding sixty-two thousand dollars, in addition to the amount of such bonds heretofore authorized for the construction of the north metropolitan sewerage works. The provisions of chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-eight and all acts in amendment thereof and in addition thereto shall, so far as they may be applicable, apply to the indebtedness authorized by this act.

Certain provisions of law to apply.

Payment of loans, etc.

SECTION 4. The treasurer and receiver general shall in addition to levying the assessments now required by law to meet the interest and sinking fund requirements of the north metropolitan system, assess annually upon the cities of Malden and Everett, in equal shares, such sums as may be necessary to satisfy the interest and sinking fund requirements of the bonds issued under the provisions of this act.

Repeal.

SECTION 5. Chapter five hundred and forty-seven of the acts of the year nineteen hundred and ten is hereby repealed.

SECTION 6. This act shall take effect upon its passage. [*Approved June 2, 1911.*

CHAPTER 541.

AN ACT RELATIVE TO WAGES OF EMPLOYEES OF THE METROPOLITAN PARK COMMISSION AND OF THE METROPOLITAN WATER AND SEWERAGE BOARD.

Be it enacted, etc., as follows:

Wages of laborers.

SECTION 1. The wages paid by the metropolitan park commission and by the metropolitan water and sewerage board to laborers directly employed by them shall be not less than two dollars and twenty-five cents a day.

SECTION 2. This act shall take effect upon its passage.

(This bill, returned by the governor to the senate, the branch in which it originated, with his objections thereto, was passed by the senate June 5, and, in concurrence, by the house of representatives June 12, the objections of the governor notwithstanding, in the manner prescribed by the Constitution; and thereby has the "force of a law".)

CHAPTER 624.

AN ACT RELATIVE TO REMOVALS, SUSPENSIONS AND TRANSFERS IN THE CIVIL SERVICE.

Be it enacted, etc., as follows:

Removals, suspensions, etc., in the civil service.

SECTION 1. Every person now holding or hereafter appointed to an office classified under the civil service rules of the commonwealth, except members of the police department of the city of Boston, of the police department of the metropolitan park commission, and except members of the district police, whether appointed for a definite or stated term, or otherwise, who is removed therefrom, lowered in rank or compensation, or suspended, or, without his consent, transferred from such office or employment to any other, may, after a public hearing, as provided for by section two of chapter three hundred and fourteen of the acts of the year nineteen hundred and four, as amended by chapter two hundred and forty-three of the acts of the year nineteen hundred and five, and within ten days after such hearing, bring a petition in the police, district or municipal court within the judicial district where such person resides, addressed to the justice of the court and praying that the action of the officer or board in removing, suspending, lowering or transferring him may be reviewed by the court, and after such notice to such officer or board as the court may think necessary, it shall review the action of said officer or board, and hear the witnesses, and shall affirm said order unless it shall appear that said order was made by said officer or board without proper cause or in bad faith, in which case said order shall be reversed and the petitioner be reinstated in his office. The decision of the justice of said police, district or municipal court shall be final and conclusive upon the parties.

SECTION 2. This act shall take effect upon its passage. [*Approved July 3, 1911.*

CHAPTER 631.

AN ACT TO PROVIDE FOR THE RECONSTRUCTION OF FOX HILL BRIDGE OVER SAUGUS RIVER BETWEEN THE CITY OF LYNN AND THE TOWN OF SAUGUS.

Be it enacted, etc., as follows:

Reconstruction of Fox Hill bridge.

SECTION 1. Whereas public necessity and convenience require the reconstruction of the joint railway and highway bridge, commonly known as Fox Hill bridge, over the tide water known as Saugus river, between the city of Lynn and the town of Saugus, the county commissioners of the county of Essex, subject to the provisions of chapter ninety-six of the Revised Laws and acts in amendment thereof and in addition thereto and of all other general laws which may be applicable, are hereby authorized and directed to reconstruct the said bridge and approaches thereto with a draw not less than forty feet wide in the open, the same to be operated by electric power.

. . . .

The metropolitan water board may operate its pipe line, etc.

SECTION 8. In the construction of the said bridge all reasonable opportunity shall be given to the metropolitan water board to maintain and operate its pipe line, now supported in part by the pile structure, and such reasonable modifications of the plans as may be necessary shall be made by the county commissioners to permit of the proper permanent relocation of the pipe either upon or adjacent to the finished structure: *provided*, that all added expense due to the protection and relocation of said water pipe shall be paid by the metropolitan water board.

Proviso.

Repeal.

SECTION 9. All acts and parts of acts inconsistent herewith are hereby repealed.

SECTION 10. This act shall take effect upon its passage. [*Approved July 7, 1911.*

CHAPTER 687.

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE SOUTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

Be it enacted, etc., as follows:

Appropriation for maintenance of south metropolitan sewerage works.

SECTION 1. A sum not exceeding one hundred and one thousand eight hundred dollars is hereby appropriated, to be paid out of the South Metropolitan System Maintenance Fund, for the cost of maintenance and operation of the south metropolitan system of sewage disposal, comprising a part of Boston, the cities of Newton and Waltham, and the towns of Brookline, Watertown, Dedham, Hyde Park and Milton, during the fiscal year ending on the thirtieth day of November, nineteen hundred and eleven.

SECTION 2. This act shall take effect upon its passage. [*Approved July 15, 1911.*

CHAPTER 691.

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE NORTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

Be it enacted, etc., as follows:

Appropriation for maintenance of north metropolitan sewerage works.

SECTION 1. A sum not exceeding one hundred and fifty-two thousand eight hundred dollars is hereby appropriated, to be paid out of the North Metropolitan System Maintenance Fund, for the maintenance and operation of the system of sewage disposal for the cities included in what is known as the north metropolitan system, during the fiscal year ending on the thirtieth day of November, nineteen hundred and eleven.

SECTION 2. This act shall take effect upon its passage. [*Approved July 15, 1911.*

CHAPTER 696.

AN ACT MAKING AN APPROPRIATION FOR OPERATING THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

Appropriation for maintenance of metropolitan water works.

SECTION 1. A sum not exceeding four hundred nineteen thousand eight hundred dollars is hereby appropriated, to be paid out of the Metropolitan Water Maintenance Fund, for the maintenance and operation of the metropolitan water system for the cities and towns in what is known as the metropolitan water district, during the fiscal year ending on the thirtieth day of November, nineteen hundred and eleven.

SECTION 2. This act shall take effect upon its passage. [*Approved July 15, 1911.*

CHAPTER 87.

RESOLVE TO PROVIDE FOR AN INVESTIGATION AND A REPORT AS TO LAKE COCHITUATE.

Metropolitan and state boards to investigate Lake Cochituate.

Resolved, That the metropolitan water and sewerage board and the state board of health are hereby requested to make an examination of the water of Lake Cochituate and of its immediate tributaries, and of the adequacy of the protection of the purity of said water, in order to determine whether or not the water is suitable for a domestic water supply, and as to the advisability of providing a method of filtration for the water. Said boards, acting jointly, shall report the result of their investigation, with such recommendations for legislation as they may deem advisable, to the general court on or before the fifteenth day of January, nineteen hundred and twelve; and they shall submit as a part of their report an estimate of the cost of a method of filtration. [*Approved June 6, 1911.*

CHAPTER 141.

RESOLVE TO PROVIDE FOR THE APPOINTMENT OF A COMMISSION TO DETERMINE WHAT DAMAGES SHALL BE PAID TO THE TOWN OF STONEHAM BY REASON OF THE TAKING FOR THE METROPOLITAN WATER WORKS OF SPOT POND.

Commission to determine damages of town of Stoneham by taking of Spot pond.

Resolved, That, upon the acceptance of this resolve by the town of Stoneham, but not more than one year after the passage thereof, said town may file in the clerk's office of the superior court for the county of Middlesex a petition for the determination of the damages sustained by it by reason of any taking or act of the metropolitan water board or of the metropolitan water and sewerage board under authority of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, and acts in amendment thereof and in addition thereto, and thereupon, after such notice as said court shall order, the court shall appoint a commission of three disinterested persons. The commission shall, after notice and hearing, determine the damages specified in the petition which said town sustained as aforesaid and could have recovered upon a petition filed in accordance with the provisions of section thirteen of said chapter four hundred and eighty-eight, and shall report its determination to said court. Such determination, when accepted by the court, shall be final and conclusive, and the town shall thereupon be precluded from bringing any further action to recover for any damages caused as aforesaid. The court may allow the members of said commission reasonable compensation for their services, and the compensation so allowed and the damages, if any, determined as aforesaid shall be paid from the treasury of the commonwealth, and thereafter shall be apportioned and paid in the same manner in which the other expenses of the metropolitan water and sewerage board are apportioned and paid. [*Approved July 19, 1911.*

CHAPTER 146.

RESOLVE TO PROVIDE FOR A COMMISSION TO INVESTIGATE THE ENGINEERING EXPENSES OF THE COMMONWEALTH.

Commission to investigate engineering expenses of the commonwealth.

Resolved, That the chairman of the board of harbor and land commissioners, the chairman of the Massachusetts highway commission, the chairman of the state board of health, the chairman of the metropolitan park commission and the chairman of the metropolitan water and sewerage board shall be a commission on engineering expenses of the commonwealth, and shall investigate the engineering salaries and expenses of the various departments, boards and commissions of the commonwealth and shall determine whether there should be any reorganization, regrouping or change in the methods of engineering done by the state boards, commissions and departments, and shall report its findings to the general court not later than January fifteenth, nineteen hundred and twelve. For the purposes of carrying out the provisions of this resolve there may be expended out of the treasury of the commonwealth a sum not exceeding one thousand dollars. [*Approved July 21, 1911.*

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